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JULY 1940

**OUR WORK IN
PUERTO RICO**



SOIL CONSERVATION

**OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON**

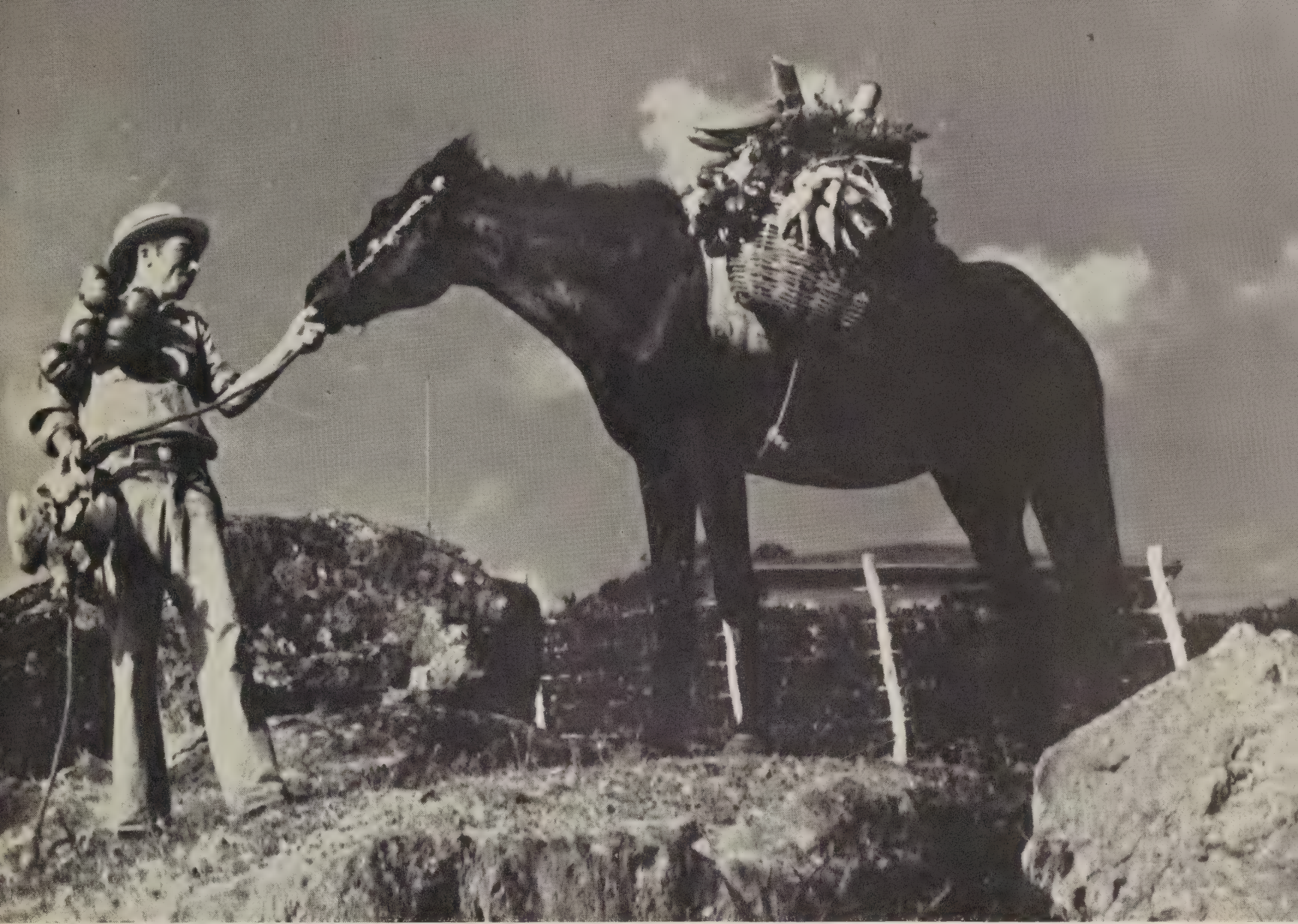
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WELLINGTON BRINK
EDITOR

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A jibaro and his pony come down the path to market from a mountain home. This tableau is enacted thousands of times any fair morning in Puerto Rico.

In one hand the jibaro holds a chicken. Berengenas—egg plants—hang from the farmer's neck. In the basket on the pony's back are bananas, turnips, more egg plants, a sampling of an amazing variety of foodstuffs.

The native pony has an aristocratic ancestry. His forebears were Arabians, introduced by the Spaniards upon discovery of Puerto Rico by Columbus four centuries ago. The Arabian stock had been brought by way of Andalusia to Puerto Rico.

The mountaineer's pony is gentle, and of great endurance. All he asks of his master at the end of a day of carrying heavy loads up and down rugged paths is to be turned loose through the night so that he may eat grass, drink water, and rest himself for another day of faithful service.

Seeking the answers to slope farming



1 Contour ditches built in a natural pasture help to conserve rainfall.

2 Run-off plots, Las Ochenta, Mayaguez area.

3 Bench terrace outlet channel.

4 Rock barriers being thrown up near Arroyo, on P. R. R. A. resettlers' land. Object: To discover the sodding qualities of the optimum degree of bank slopes. These bench terraces are at Mayaguez.

SOIL CONSERVATION

HENRY A. WALLACE
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

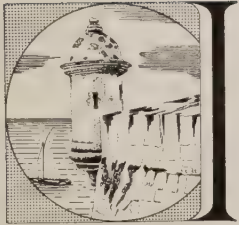
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JULY • 1940

SOIL CONSERVATION PROGRAM IN PUERTO RICO

By G. L. CRAWFORD¹



IN 1935 SOIL CONSERVATION SERVICE employees made a reconnaissance erosion survey in Puerto Rico and located problem areas. Through the cooperative efforts of the Puerto Rico Reconstruction Administration (commonly called the "P. R. R. A."), the Puerto Rican Experiment Station of the United States Department of Agriculture at Mayaguez and the Forestry Service, the soil conservation camp at Las Mesas, near Mayaguez, was set up and began work with a corps of 200 men in September 1936. The men were employed in constructing bench terraces with simple hand tools on land having an average slope of 35 percent.

During a period of experimentation, while the type of bench terrace suited to Puerto Rico was being developed, the organization plans for an island-wide soil conservation program were outlined. The program was developed through conferences and contacts with interested people, and its final crystalization and the job of putting it into practice were realized largely through the assistance of the Soil Conservation Advisory Committee. From the beginning, this committee has been composed of the heads of the following organizations: Agricultural Extension Service, Department of Agriculture and Commerce, Rural Rehabilitation Division of the Puerto Rico Reconstruction Administration, insular and Federal experiment stations, Agricultural Adjustment Administration, United States Forest Service, College of Agriculture and Mechanic Arts, and Soil Conservation Service.

It was decided that an agricultural engineer, and an agronomist well trained in soil conservation methods, should be placed at each soil conservation area. Two soils specialists were to be located at the headquarters' office, with the understanding that their activities cover the island. Additional funds were supplied through the cooperation of the P. R. R. A. and 20 local college graduates trained in engineering, agronomy, and soils were employed. Such, in brief, is the genesis of the general plan for operations that has been followed until the present time.

Gradually, through the increase of funds allotted by the P. R. R. A. for soil conservation work, it has been possible to add to the organization's personnel and to spread the Soil Conservation Service personnel over the island. At present, about 60 local technical men are employed and about 1,500 skilled, semiskilled, and unskilled laborers. Each Soil Conservation Service technician is supervising from two to four areas.

¹ In charge, Soil Conservation Service, U. S. Department of Agriculture, Puerto Rico and Virgin Islands.

On March 1937, plans were completed for a soil conservation experiment station to be located at Mayaguez on Federal land occupied by the Puerto Rico Experiment Station of the United States Department of Agriculture. The work was to be carried on in cooperation with the director. On January 1938, another soil conservation experiment station was started at Rio Piedras, on insular land occupied by the Agricultural Experiment Station of the University of Puerto Rico, and in cooperation with the director.

Careful estimates show that 40 percent or more of the arable land of Puerto Rico has a slope of 40 percent or greater. The population amounts to more than 500 people per square mile, and about 80 percent of them depend directly or indirectly upon agriculture for a livelihood. In view of this it is apparent that an adequate soil conservation program in Puerto Rico must embrace the successful control of erosion and conservation of moisture on steep mountainsides. Therefore, the first important problems to be outlined at the Mayaguez station included the control of bench terrace banks. After the proper slope of the bank was determined, and the type of grass best adapted for bank cover, an experiment was started for the specific purpose of finding a food crop that could be grown on these banks in place of the grass cover. This experiment is still in progress.

Another important feature of the research program for this station is that involving the development of a cheaper method of building bench terraces than the hand construction method. Experimentation along this line has resulted in the vegetative barrier method—stiff upright-growing plants are planted on the contour or a slight grade at intervals of from 3 to 8 feet on the mountainsides. By the normal process of preparing land and cultivating crops, a bench terrace is formed in 3 to 5 years.

These are two of the major problems which the Mayaguez station has been working on during the past 3 years. In addition, projects are being carried out to determine the relative values of different types of vegetation, and to estimate the erodibility of fallow land and subsoil through the use of run-off measuring plots.

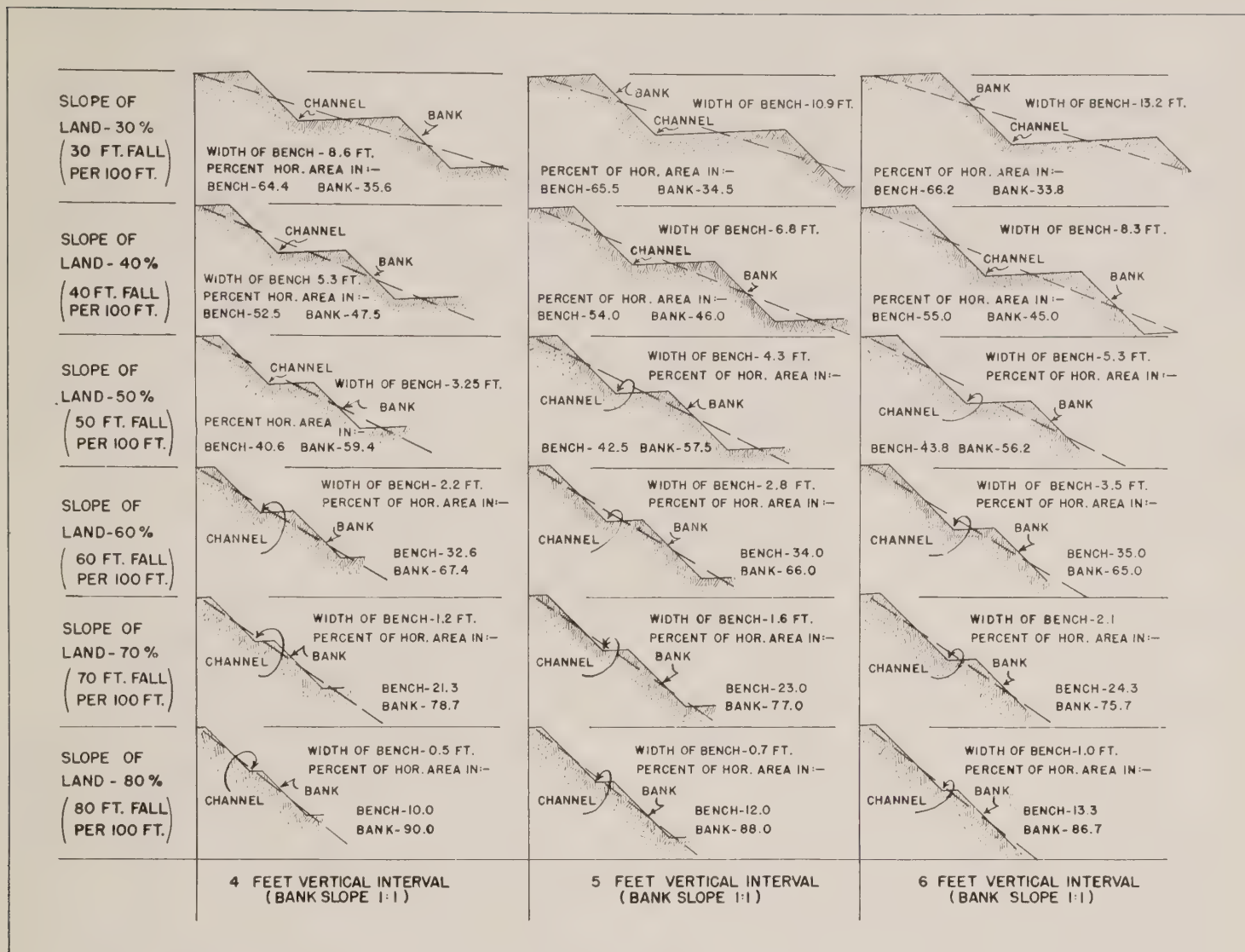
As it was generally recognized that grasses play a tremendous part in soil conservation, the Rio Piedras Agricultural Experiment Station turned over to the Soil Conservation Station the plots of ground on which they had been working with grasses. These plots have been increased until at present the Soil Conservation Experiment Station has more than two hundred

$\frac{1}{100}$ -acre plots. The Soil Conservation Service is not only making detailed studies of the root systems, crown and growth characteristics of the grasses, but also is cooperating with the Insular Experiment Station and the School of Tropical Medicine in making analyses of the grasses as to their nutritional value. Digestive tests will be made on some of the plants this year. In addition, the Rio Piedras station is carrying on a cooperative experiment with the Insular Experiment Station in studying the erodibility of soils as related to their chemical and physical properties. These tests, in turn, are being made on the soils of the run-off plots at Mayaguez.

The operations program, as previously indicated, deals necessarily with slopes, many of which are very steep. The soil conservation surveys in Puerto Rico indicate not only the type of soil, extent of erosion and degree of slope, but also the depth to rock. This is of vital importance to the engineer in determining the kind of structure to be installed on each particular slope. For example, if the depth to rock is 4 feet, it is possible to plant barriers at a vertical interval of 5 feet and build a bench terrace in 3 to 5 years without exposing rock. On the other hand, if the survey indicates that the rock is within 15 inches of the surface, it is impractical to build bench terraces, and some other structure must be installed on the field. The engineering problems are many when it comes to developing a land-use program on the mountainous soils of Puerto Rico. The steeper the slope, the narrower will be the bench—with a vertical interval of 4 feet and a slope of 30 percent, the bench will be about $8\frac{1}{2}$ feet wide; but if the slope is 70 percent, other things being equal the bench will be about 1 foot wide.

As for the agronomist's problems, he not only must establish vegetation in outlet channels for permanent use and service at the minimum upkeep, on slopes up to 70 percent, but he must be on the lookout constantly for new methods of placing vegetation in these outlets, as the work is rather expensive and the best-known materials are scarce. The Soil Conservation Service agronomists in Puerto Rico have been called on by other agencies, such as the Insular Highway Department, to assist in establishing vegetation on steep slopes. Technicians of the Soil Conservation Service in Puerto Rico face new problems at almost every turn; to date they have had about 3 years' experience working with small farmers on the island.

About two thousand resettlers' farms have been developed according to soil conservation methods. An agreement was entered into between the farm superintendent in the resettlers' area, the farmer, the



agricultural extension agent, and a representative of the Soil Conservation Service, and from the agreement a 5-year program has been set up. In many instances farmers are now deriving a subsistence living from their farms. The small farmers in the mountain areas are being offered an opportunity to cooperate in a soil conservation program. This includes not only structures, such as hillside ditches and contour cultivation, but also a crop rotation plan to supply adequate food for the family and add humus to the soil for gradual increase of its productiveness. Also the farmer is being given several months' work under the supervision of a personnel trained in soil-conservation methods. This program is supplying him with funds while he develops his farm for a greater production.

The Soil Conservation Service is now working in 4 areas with about 500 private farms. More than 85 percent of these farmers have entered into a contract with the P. R. R. A. to cooperate in the soil conservation program. It is expected that at least 95 percent of the farmers in each area will cooperate in the program before the work is completed. This indicates a good attitude on the part of the small farmers of the

island toward an agency trying to assist them to become economically independent.

The soil conservation program in Puerto Rico would be much more difficult than it is were it not for the splendid cooperation and friendly assistance received from other agencies on the island. The P. R. R. A. not only has assisted the program by supplying funds but has offered encouragement whenever possible.

The Commissioner of Agriculture and Commerce has been for a long time a strong supporter of the soil conservation idea. He started a research project in soil conservation at the Rio Piedras station a number of years ago.

The University of Puerto Rico Agricultural Experiment Station at Rio Piedras is cooperating by supplying office space and land, and in developing a cooperative project for the study of the erodibility of Puerto Rican soils according to soil types.

The Federal experiment station at Mayaguez has fostered the work from its inception, not only by giving timely advice but also by supplying office space, land, and other valuable assistance.

The Forestry Service, both Federal and insular, has



cooperated fully in supplying assistance and aiding in the development of cooperative projects in the National Forest.

The Director of the Extension Service has spent many hours in inspecting soil conservation practices, and has encouraged the extension staff and county agents to take an interest in the program. The county agents have assisted in selecting areas, through local farm groups, and have supported the work after its establishment in the areas.

The Director of the vocational board of education has taken an active interest in the work, and soil conservation methods are now being developed on the school farms of 116 vocational schools in Puerto Rico.

The agricultural college at Mayaguez has cooperated in training technical personnel and in establishing soil-conservation methods on the college grounds. Cooperative projects have been organized among heads of the department of engineering, the department of agronomy, and the Soil Conservation Service, whereby the students participate in the work.

The Polytechnic Institute of San German has encouraged the work, and is now offering night classes in soil conservation to its farm help and neighboring farmers.

The sugar industry has cooperated by conducting demonstrations in growing sugarcane on hillsides.

The highway departments, both Federal and insular, are cooperating and have appointed a liaison officer with the view of installing soil-conservation methods on the roadside ditches, road banks, and road fills in Puerto Rico.

The insular irrigation and water resources organizations have cooperated in supplying basic data on stream flow, silting, flood damage, and other useful data in developing a soil conservation program.

The Department of Health is cooperating by exam-

ining the health of the farmers in the soil conservation areas, and providing more sanitary facilities.

The penitentiary and insane asylum have requested the assistance of the Soil Conservation Service in developing a soil conservation program on the farms of these institutions.

The program has now been extended to the Virgin Islands, and has attracted attention in Jamaica, Haiti, Hawaii, Ecuador, Colombia, and Venezuela. This has been possible only through the vision of the chief of the Soil Conservation Service in Washington in starting the work, and the cooperative attitude and assistance given by both Federal and insular organizations in the island of Puerto Rico.

Authors' Acknowledgments

Trailing Indigo, a Promising Leguminous Forage Plant, by Robert L. Davis and Bernardo Fiol Villalobos. Page 29. To the Puerto Rico Experiment Station of the United States Department of Agriculture, which supplied land; to the Puerto Rico Reconstruction Administration, for labor and technical supervision.

Use and Limitations of Trash Barriers, by Robert L. Davis. Page 24. To the Puerto Rico Reconstruction Administration, which supplied labor, technical supervision, and land.

Tillage Tests on Puerto Rican Bench Terraces of Mucara Clay, by Robert L. Davis. Page 21. To the Puerto Rico Reconstruction Administration, which supplied labor, supplies, and technical assistance; to the Puerto Rico Experiment Station of the United States Department of Agriculture, which supplied the land and helped in the construction of terraces.

Pasture Treatment in the Ohio Valley

On the Leatherwood Creek project near Bedford, Ind., farm records secured by Marion M. Merritt and J. M. Rudy show that several farm pastures treated with $1\frac{1}{2}$ and 2 tons of lime and 400 pounds of superphosphate (20 percent) per acre, produced about twice as much forage as similar pasture land that was not treated. Records were kept on 6 farms in 1938 and on 12 farms in 1939. The increased returns nearly paid for the lime and fertilizer the first year. Another application will not be needed for 3 to 5 years. Such treatment of poor pastures is justified also because it makes possible a thicker cover of vegetation to reduce soil losses and run-off, provides a more nutritious feed, and encourages farmers to keep more of their land in grass. More details of this are reported in Regional Circular 188, Dayton, Ohio, April 25, 1940.—A. T. Semple.

SOIL CONSERVATION A UNIQUE PROBLEM IN PUERTO RICO

By C. A. PRICE ¹

PUERTO RICO is an island of extremes, for within its bounds are found great variations most of which affect the agriculture either directly or indirectly. Before one can appreciate the problems that face the Soil Conservation Service in the island, he first must know something about the variations found in the type of agriculture, climate, topography, geology, and vegetation.

Puerto Rico is located at the eastern extremity of the Greater Antillean islands, commonly called the West Indies. It is approximately 1,400 miles south and east of New York City, and 1,000 miles east and south of Miami, Fla. The island itself is about 100 miles long by 40 miles wide. Recently it has been included in Region 2 of the Soil Conservation Service, with headquarters at Spartanburg, S. C.

Perhaps the most constant feature of the island is the temperature, although there is a difference of about 10° F. in the mean annual temperature between the coastal lowlands and the highest mountain districts which average approximately 78° F. and 68° F., respectively. But there are only slight seasonal and daily fluctuations in temperature; frost, or temperature above 102° F. have never been recorded. In this tropical area the northeast trade winds blow almost continually, depositing much rain on the steep mountainsides of the island, while the bordering ocean waters tend to regulate and smooth out temperature fluctuations.

On the other hand, the climate of Puerto Rico is decidedly variable when the amount and distribution of rainfall is taken into account. The mean annual rainfall of the island will vary from 26 inches in places on the south coast to 200 inches in the northeastern mountainous region. A distance of approximately 60

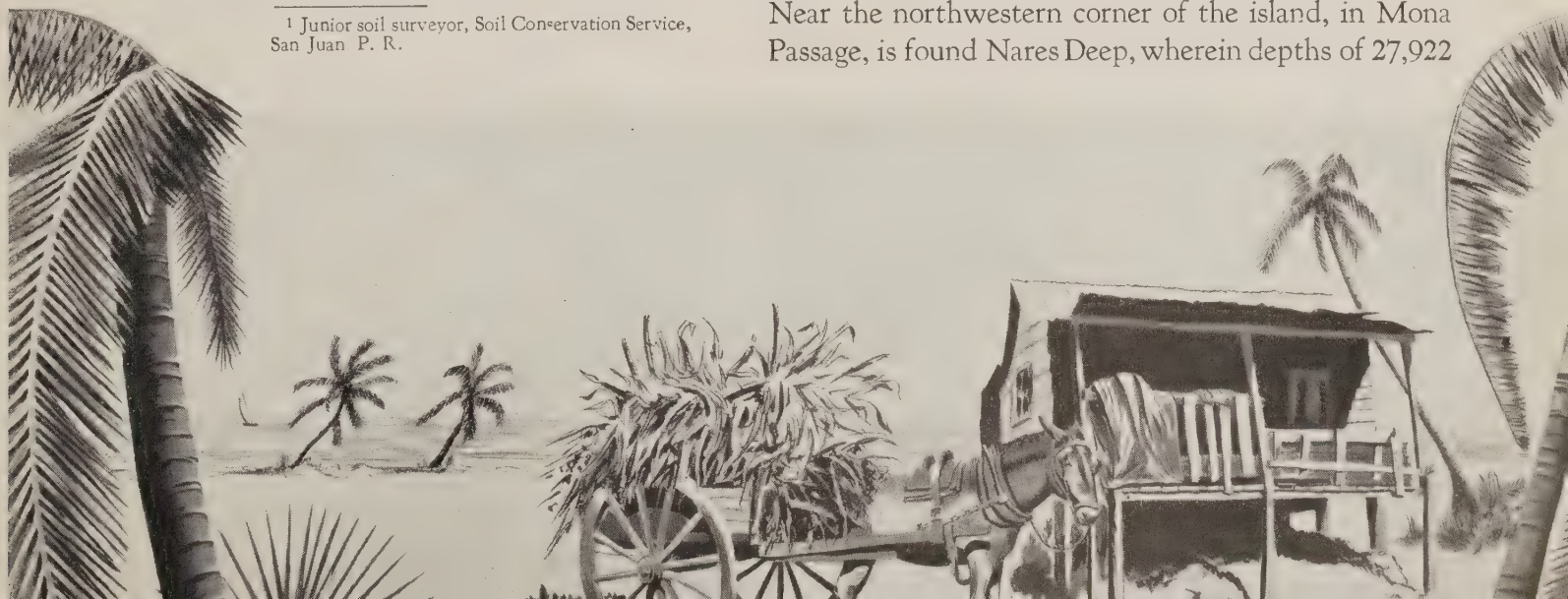
miles separates these regions. In some places there is too much rainfall for the growing of certain crops, and in other places nearby irrigation must be used in order to grow almost any crop. Parts of the southwestern section of the island may be classed as semidesert, while tropical rain forests are found in other sections. The continually blowing trade winds, the high percentage of cloudless days and the tropical position of Puerto Rico make the evaporation ratio high. It has been estimated that 35 inches of rain on the north coast of the island is equivalent to about 15 inches in the northern Great Plains region of the continental United States.

The topography of Puerto Rico is extremely variable; it ranges from the flat alluvial lands on parts of the coast to the high cone-shaped mountains of the interior with their characteristic steep V-shaped valleys. The elevation range is from sea level to 4,400 feet in the high mountains of *Los Picahos* near the center of the island.

The geology of Puerto Rico is extremely complicated due to the fact that the ocean waters almost completely covered the island several times in its past geological history.

Considering the Archeozoic, Proterozoic, and Paleozoic eras as representing 85 percent of all geologic time, it is surprising to know that nearly all the rocks found in the Greater Antilles were formed during the last 12 percent of earth's history. In brief, it may be said that the central core of Cretaceous sedimentary and volcanic rocks is bordered by the Tertiary limestones and recently deposited material of the coastal sections. The island itself is supposed to represent part of the top of a mountain chain which extends deeply into the Atlantic Ocean and Caribbean Sea. Near the northwestern corner of the island, in Mona Passage, is found Nares Deep, wherein depths of 27,922

¹ Junior soil surveyor, Soil Conservation Service, San Juan P. R.



feet are recorded. Off the southern coast, depths of from 12,000 to 16,000 feet are common. It has been said that "if the waters of the Atlantic and Caribbean could be drained, the Great Antillean islands would appear as one of the most imposing mountain elements on the earth," and that "Cerro de Punta, the highest summit in Puerto Rico, would surpass Mount Everest when viewed from the north, and would equal the highest peaks of the Andes when seen from the south."²

The past geologic periods have not been very kind to Puerto Rico. No coal or oil has been found on the island, and the precious metals are very limited. Only one manganese mine has enjoyed any kind of success. A large deposit of iron-bearing earth, classed as a laterite soil, has been formed; but without fuel this deposit seems destined to lie unused for many years in the future.

The vegetation of the island as seen in most places today would present a striking contrast to the natural vegetation that the early Spanish explorers found in Puerto Rico. Almost all the most important cultivated plants are exotic to the island. Plants such as sugarcane, coffee, bananas, grapefruits, and coconuts have been introduced. The virgin tropical forests have been almost entirely cut away to make room for the cultivation of crops. Farming on steep slopes for several hundreds of years has brought with it great erosional losses of the soil. Mountain streams which in the past ran clear and pure are now muddy and impure after each rainfall. Puerto Rico has well-defined natural tropical forest regions, grass regions, swamp regions, and desert regions. Under these different types of vegetation, different soils and different types of agriculture have developed. Each region calls for its special kind of soil-conservation practices.

² Geology of Puerto Rico. By Howard A. Meyerhoff. 1933.

The total land area of Puerto Rico, including the adjacent and dependent islands, has been given by the Insular Department of Interior as 3,400.6 square miles. The total population according to the 1935 census was 1,723,534. The average number of inhabitants per square mile in 1935 was therefore 506.8 which may be compared with 454.0 in 1930, 383.2 in 1920, 328.8 in 1910, and 280.3 in 1899 when Puerto Rico was ceded to the United States. In density of population the island may be compared to the older European countries, although these countries have many more natural resources and industries than are found in Puerto Rico.

With 506.8 people per square mile, Puerto Rico has an average of only 0.48 acre of arable land per person. Of the total 2,113,704 cuerdas³ of land, 90.5 percent, or 1,913,047 cuerdas were in farmland in 1935. In 1910, 98.6 percent was in farmland; in 1920, 95.7; in 1930, 93.6. From 1910 to 1935 the total land in farms decreased, and the total number of farms decreased almost 10 percent. In 1910 there were 58,078 farms; in 1930, 52,965; in 1935, 52,790. The average farm in 1935 was 36.2 cuerdas in size with an average value of \$81.69 per cuerda, the value of land ranging from \$10 to \$1,000 a cuerda. The very high-priced land is found on the coastal alluvial lands and is entirely devoted to sugarcane. Some of this land has been planted to sugarcane for 80 or more successive years, and at the present is producing more sugar per acre than ever before due to the efficient and heavy use of fertilizers, to irrigation, improved varieties, and cultural practices.

Actually, however, the average figures given above mean little unless we consider the distribution of farmland and cropland. The table shows the classification of farms by number and size based on all land in farms.

Of a total of 52,790 farms in Puerto Rico, 44,195 or 83.7 percent are less than 35 cuerdas in size, which

³ 1 cuerda = 0.97 acre.

Table showing number and size of farms in Puerto Rico, 1935*

Size of farm in cuerdas	Farms		Area of land in farms		Area of cropland		Average size of farm	Average cropland per farm
	Number	Percent	Cuerdas	Percent	Cuerdas	Percent	Cuerdas	Cuerdas
Less than 3	1,782	3.4	3,305	0.2	3,057	0.4	1.9	1.7
3-5	15,223	28.8	59,448	3.1	41,442	5.0	3.9	2.7
6-9	10,103	19.1	72,372	3.8	41,523	5.0	7.2	4.1
10-14	7,387	14.0	85,170	4.5	44,013	5.3	11.5	6.0
15-19	3,779	7.2	62,600	3.3	29,602	3.6	16.6	7.8
20-34	5,921	11.2	149,909	7.8	67,012	8.1	25.3	11.3
35-49	2,468	4.7	100,430	5.2	41,966	5.1	40.7	17.0
50-99	3,137	5.9	211,324	11.0	86,511	10.5	67.4	27.6
100-199	1,731	3.3	234,621	12.3	99,274	12.0	135.5	57.4
200-499	924	1.8	270,410	14.1	117,108	14.2	292.7	126.7
500 and over	335	.6	663,458	34.7	225,842	30.9	1,980.5	763.7
Total	52,790	100.0	1,913,047	100.0	827,350	100.0	36.2	15.7

*Condensed from table No. 10, Agriculture Census of Puerto Rico, 1935.

is to say that 83.7 percent are less than the average farm size. Of the total, 49,800 or 94.3 percent are less than 100 cuerdas. Only 335 farms, or 0.6 percent of the total number, are 500 acres or more in size; but these farms total 663,458 cuerdas, as compared with the farms of less than 100 cuerdas which represent 94.3 percent of the total number and occupy 744,558 cuerdas of land. These figures show clearly one "extreme variation" in the type of agriculture in Puerto Rico. Most of the large farms are under the control of corporations and are mostly planted to sugarcane. This type of farming is found mainly on the rich alluvial coastal lands and in the interior valleys of the island. Since 90.5 percent of the land of Puerto Rico is in farms, it is not difficult to see that the small-farm type of agriculture occupies the land not devoted to sugarcane, that is, the steep-sloped mountainsides of the interior. Likewise, when it is

considered that the elevation ranges from sea level to 4,000 feet or more 20 miles within the interior, it is not difficult to picture the steep slopes and the hazards of a type of farming largely devoted to tobacco, pineapples, and minor crops with the soil clean cultivated and left bare several times in a year.

Puerto Rico is fundamentally an agricultural country. Its future lies in agriculture and its development. At the present time Puerto Rico imports some \$90,000,000 worth of materials from the continental United States each year, a large percentage of which may be charged to foodstuffs. The job of the Soil Conservation Service in the island is to help conserve the soil so that food production can be not only maintained for the present but increased in the future. The obstacles are numerous and severe, yet the Puerto Ricans realize more and more that their future depends to a large degree upon saving their soils.

RIO GRANDE DE LA PLATA AND SOIL CONSERVATION

By W. G. KINCANNON ¹

A CIRCUITOUS route is followed in traveling southward from San Juan, P. R., on Military Road No. 1. After 61 kilometers, or about 38 miles, you come to the town of Cayey lying in a valley in the mountains that occupy so much of the interior of the island. Cayey and the surrounding countryside is said to be about 2,000 feet above sea level. The weather is pleasant, as the evenings and nights are cool and the days generally not uncomfortably warm. The mean temperature, summer and winter, varies not more than 10°. The annual rainfall averages 55 inches and is characterized by many rainstorms of high intensities. The months of January, February, June, July, and August are rather dry and crops sometimes suffer.

Should the traveler turn left from Military Road No. 1 before reaching Cayey and shortly after leaving Las Cruces he might view a landscape dotted with little varicolored houses and small fields terraced and contour-tilled. This is the Guavate group of resettlers' farms of the Puerto Rico Reconstruction Administration. Farther along the highway from Cayey to Cidra, is the Cidra group, and then on the road to Comerio at the left of the highway and across Rio Grande de La Plata, in a landscape beautiful in its symmetry, is the Comerio group.

Starting again from Cayey and proceeding west-

ward on Military Road No. 1, toward Aibonito, the traveler will barely have left Cayey before he is within the area of the Buena Vista group. After leaving Buena Vista he reaches the Maton group, and then with much turning and twisting along the mountain road he finally comes to the observation platform overlooking the La Plata group. La Plata is a fitting climax for a tour of the Cayey area of the P. R. R. A. Little La Plata Mountain stands like a dunce cap in the valley of Rio Grande de La Plata. Its slopes are symmetrically striped with contour strips of green crops and narrow strips of barrier plantings. The valley at the foot of La Plata and the slopes reaching upward from the Rio Grande de La Plata are similarly patterned.

The tour just outlined would take the traveler along the "front yard" of the work that has been done in the Cayey area by the Soil Conservation Service and the Puerto Rico Reconstruction Administration to control erosion and for agricultural resettlement. The work of conserving the soil on resettlers' farms in the area was started when the Soil Conservation Service established an office in Cayey in September 1937. Nineteen farms, ranging in size from 22 to 700 acres, were purchased and subdivided into small resettlers' farms, each 5 to 14 acres in size and averaging 6 acres. A system of agriculture to conserve soil and retain soil fertility and moisture was designed and its installation planned for all resettlers' farms. By December 1939

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the work of establishing the practices was approximately 90 percent complete. On completed areas it required only satisfactory maintenance on the part of the *parceleros* (resettlers).

It was not an easy matter, however, to establish conservation practices in the area. Farmers were not accustomed to contour tillage and terraces, and there was little background upon which to base recommendations of practices for farming on mountain slopes. Systematic rotations never before had been used by the small farmers.

The land purchased by the P. R. R. A. for resettlement lay almost entirely in mountainous terrain. Topographically, the whole area is characterized as a Cretaceous peneplain roughly and highly dissected, with the relatively narrow valleys bounded by precipitous slopes. The resulting hills are more or less knife-edged with gradients of from 25 to 75 percent and extremely undulating slope conditions. Extending from the bases of the hills are colluvial slopes, less severe but generally rolling in nature. The flow lines of intermittent streams leading to the Rio Grande de La Plata have gradients often ranging from 10 to 25 percent. The soils over the entire area are predominantly clays and silty clays of varying depths above the rocky parent material.

For purposes of standardization of method and of training personnel for conservation work, a generalized scheme of conservation operations was devised gradually. In the development of the procedure, and by its application, the establishment of demonstrations and trials was accomplished. The scheme was necessarily tentative and it may therefore be changed from time to time; but nevertheless it lends itself to the generally recommended plan of land-use capabilities.

After a study of conditions of soil and slope along with some of the engineering and agronomic limitations so imposed, eight groupings were made, each of which embodied pertinent physical factors and recommended applications. This grouping is outlined below. The numerical arrangement of groups is designed to point out the conditions most difficult to cope with as they range into the more favorable situations. Somewhere in the Cayey area each group recommendation has been put into practice.

Group 1.—The Mucara, Los Guineos, Cialitos, and Naranjito soils are included in this group when situated on slopes greater than 30 percent if erosion has been so severe as to remove more than 75 percent of the topsoil. Also included in the group are all soils situated on slopes greater than 75 percent,

irrespective of the degree of erosion. The soils falling in the group are described as derivatives of Cretaceous volcanic pyroclastic rocks, with andesitic tuff, minor ash, and shale origin. The depth of the Mucara soil ranges from 2 to 10 inches, and the depth of the others from 2 to 10 feet.

Crop cultivation is not considered practical for such conditions. Instead, development into pasture or forest is recommended, with contour furrowing on 2-foot vertical spacings for moisture conservation. Each furrow should be blocked at 10-foot intervals in the manner of basin listing. In the cultivation of forest trees it is recommended that the surface of the soil be disturbed only for short distances about each tree in crown cultivation.

Group 2.—This group comprises the Mucara and Naranjito soils on slopes ranging from 45 to 75 percent, with slight to moderate erosion or with 25 to 75 percent of the topsoil eroded away. The soil is usually from 4 to 8 inches in depth.

It is conceded without question that the better practice would be retirement of such terrain to pasture or forest. It must be remembered, however, that the density of population in Puerto Rico and the accompanying seriousness of the economic condition of *el jibaro* (the country man) make thorough utilization of the land necessary. For this reason a 2-year or longer crop rotation is established on land falling within this group. Tobacco, sweet potatoes, beans, vegetables, and grasses are recommended in conjunction with the regular planting of leguminous green-manure crops. Mechanical handling of surplus water is not considered wise; instead, contour tillage is induced by the windrowing of field trash and crop residue along lines laid on a grade not exceeding an 0.8-foot fall for 100 feet. The vertical interval of such barriers, or buffer strips, is not greater than 6 feet—this because subsequent plowing of the interval, and soil flow, cause deposition at the barriers and eventually the formation of bench terraces. As the bench forms, stiff-stemmed grasses may or may not be planted in the barrier further to induce deposition, and stoloniferous grasses may be planted on the gradually forming bank below the barrier to strengthen the bench.

Group 3.—Catalina soil is a Cretaceous soil originating from andesitic tuffs, ash, and shale, and has a solum depth of 10 to 15 feet. Its occurrence, along with that of Cialitos and Los Guineos soils, on slopes from 45 to 75 percent where erosion has removed over 75 percent of the original topsoil comprises the third group.



Hillside ditches and contour cultivation make an interesting pattern on this La Plata farm near Cayey. Conservation practices are in evidence on Little La Plata Hill in the right foreground.

Treatment for conditions of this group are identical with those for Group 2, except that the greater depth of the topsoil of the soils here found allow the growth of a wider variety of crops. To the crops and rotations of Group 2 are added Irish potatoes, rice, and the tropical crops, yams, yautias, plantains, and bananas.

Group 4.—The soils, degrees of erosion, and crops of Group 4 are the same as for Group 2, the difference being that in this group the slopes range from 15 to 45 percent. Recommended practices therefore differ, not in agronomic, but in engineering features.

Eventual bench-terrace formation is again foreseen but through a different method of handling surplus surface water. The necessity of regular interception and confined disposal was deemed necessary; hence small ditches, or diversions, on grades not in excess of 1 percent, are dug around the slopes on vertical spacings of not more than 6 feet. Field trash and crop residues are deposited parallel to the ditches on their uphill bank, thus allowing bench formation from that point and still maintaining water interception at the foot of the gradually forming bench. When the bench has formed to a height whereby it is no longer safe or practical to utilize the original diversion ditch for interception, it is erased and a new small ditch is established just above the barrier. As the bench further forms, the necessity of the ditch is removed by the establishment of a bench terrace, not flat, but having a channel for water diversion at the foot of the bench above. Thus a channel is again placed in the original lateral position of the ditch but on a lower level, and the bench terrace becomes also a channel-type terrace.

Group 5.—In this group are included the deeper phases of Cialitos, Los Guineos, Catalina, and Naranjito

soils on slopes from 15 to 45 percent where erosion has removed from 25 to 75 percent of the topsoil.

The agronomic practices of Group 3 are again recommended here. Water interception and bench formation are secured by the construction of furrows on grades no greater than 1 percent and spaced vertically not over 6 feet. Cane-like grasses, such as Merker and elephant grasses, are planted on the downhill bank of the furrow. As the bench forms by soil manipulation and flow against the plant barrier, the furrow channel moves toward the bench above until it eventually is established at the foot of the bench.

Group 6.—Cialitos, Catalina, and Los Guineos soils of Group 5, on slopes of 15 to 40 percent only, are included in this group. Agronomic practices are the same as previously recommended, the difference being only in the method of mechanical manipulation.

Where justified economically, the bench terraces are constructed outright, with diversion of water handled by channeling the bench with a 1-percent slope of bench surface toward the toe of the terrace above. Grade along the bench should not exceed 0.8 percent and vertical spacing 6 feet. Bank slope of the bench should be as near the natural angle of repose of the soil as practicable (1:1 slope, approximately) with stoloniferous grasses for added safety and protection.

Group 7.—Catalina, Mucara, Cialitos, Moli, Toa, and Estacion soils on slopes less than 15 percent comprise this group. The latter three soils include erosive deposition (colluvial) and rock weathering of slightly different geological history than the other soils.

Agronomic practices remain unchanged for this group, being the same as for Group 3. Instead of bench terracing by any means, a modified ridge or

(Continued on p. 20)

HOW EROSION EFFECTS OF INTENSIVE RAINS ON STEEP SLOPES MAY BE DECREASED

By JOEL W. ELLIOTT ¹



Left to right: sour paspalum, sweet potatoes, fallow, guinea grass.

CATALINA clay slopes of 35 to 45 percent have been considered representative of large areas requiring erosion protection in Puerto Rico. In view of this, run-off plots with catchment tanks were located on such clay slopes near Mayaguez and put into operation on June 1, 1938.²

The history of this land for the past 40 years is somewhat as follows: For 20 years it was overgrazed pasture; then followed 10 years of use in clean cultivation around experimental plants; during the last 10 years the land lay in unproductive abandonment. Erosion was moderate to severe. Much of the topsoil from these slopes had been lost through the uses to which the soil was subjected in combination with the average rainfall of 81.7 inches a year. In spite of the rainfall, water conservation is an important feature, as precipitation is concentrated in about 8 months of the year.

The land was cleared, plowed, leveled, and planted with cover crops in alternate horizontal strips.³ Six months later the field was replowed and harrowed and

the plots were leveled horizontally and planted in small contour sections. In this way the slopes and soil profiles were disturbed as little as possible and care was taken to guard against excessive erosion during the preparation period. An 8-14-14 fertilizer was applied at the time of all plantings.

Nine pairs of duplicate plots, one-seventieth acre each, were thus located on slopes of 35 to 42 percent and put in operation on June 1, 1938. All vegetative covers were well established by this time as planting had been done 6 months previously. Later, certain of the species failed and were replaced by cultivated crops. All plots have horizontal lengths of 51.86 feet and widths of 12 feet. Sheet-metal border plates completely surround each plot on the two sides and upper end. On the lower end the plate is driven flush with the ground so that all run-off flows on to a covered sheet-metal apron and is led through a flume into a round sheet-metal settling tank. Overflow from this passes through a "Geib Multislot Divisor" which allows one-seventh or one-ninth to go into a second sheet-metal tank. All tanks, flumes, and divisors have sheet-metal covers to prevent entrance of rain. After each rain the mixture of run-off and soil in the tanks is

¹ Assistant soil technologist, Soil Conservation Service, Mayaguez, P. R.

² All field equipment was designed and installed by V. W. Thalman, associate agricultural engineer, Soil Conservation Service, and A. Roura, principal engineering aide, Puerto Rico Reconstruction Administration.

³ Agronomical planning and supervision were rendered by R. L. Davis, agronomist, Soil Conservation Service, Mayaguez, P. R.

TABLE 1.—Summary of rainfall data from May 1, 1938, to Dec. 31, 1939 (U. S. Department of Agriculture, Soil Conservation Service Research Station, Mayaguez, P. R.)

Months	Stormy days having run-off	Total rainfall			Average duration of--		Intensities in inches per hour for rains causing run-off			
		39-year average	1938-39 actual	Causing run-off	Storm causing run-off	Falling rain causing run-off	Maximum for--		Average for period of--	
							5 min.	30 min.	Storm	Falling rain
1938	Number	Inches	Inches	Inches	Hrs. Min.	Hrs. Min.	Inches	Inches	Inches	Inches
May.....	11	8.27	9.69	8.69	3 18	2 53	3.00	1.50	0.26	0.30
June.....	7	8.97	7.38	6.06	4 29	2 48	4.50	1.70	0.19	0.31
July.....	13	10.73	11.92	11.08	3 04	1 28	4.50	3.25	0.28	0.58
August.....	9	11.37	6.11	5.71	2 43	1 20	5.00	2.00	0.23	0.47
September.....	16	10.89	11.95	11.71	2 50	1 05	3.50	2.60	0.26	0.67
October.....	7	9.79	4.63	3.70	56	37	3.00	1.45	0.57	0.84
November.....	10	5.95	5.58	4.91	1 21	38	4.20	1.86	0.36	0.78
December.....	5	2.60	4.70	4.48	49	49	3.80	2.60	0.11	0.11
1939										
January.....	1	2.00	0.86	0.52	1 20	1 20	1.20	0.64	0.39	0.39
February.....	1	2.18	1.43	0.90	1 40	1 00	2.28	0.78	0.54	0.90
March.....	6	3.78	7.28	6.40	3 55	1 35	3.84	1.84	0.27	0.77
April.....	8	5.17	4.86	3.81	2 39	51	3.12	1.40	0.18	0.56
May.....	13	8.27	9.91	8.69	2 00	1 30	5.52	2.92	0.33	0.44
June.....	5	8.97	5.63	4.90	2 43	1 44	3.12	1.30	0.36	0.56
July.....	12	10.73	13.28	12.43	2 18	1 37	5.24	2.06	0.45	0.60
August.....	15	11.37	14.11	13.84	2 46	1 03	4.32	2.92	0.33	0.87
September.....	8	10.89	6.00	4.53	2 14	1 35	3.36	1.76	0.29	0.41
October.....	9	9.79	7.34	5.89	1 23	1 08	3.12	2.32	0.47	0.58
November.....	6	5.95	3.42	2.72	2 35	2 35	1.92	0.76	0.17	0.17
December.....	3	2.60	1.67	1.36	3 46	3 00	1.56	0.64	0.12	0.15

allowed to settle. Top liquid and sludge (underlying mud and water) are separately drawn off and each is weighed and sampled in increments. Proportionate sampling builds composite samples of each. The percentage of oven-dry soil and water in the samples are determined in duplicate. From these percentages and the total weights of top liquid and sludge, the actual amount of dry soil and of run-off water from each storm is determined.

Rainfall and rainfall intensities are ascertained for each storm by standard and recording rain gages. The prevailing rains at Mayaguez are of the convectional current type. Clouds will cover the sky over a limited area, then let go, and hurl their water upon the slopes below. Two or three such rains falling during 1½ hours may comprise a storm period lasting from 1½ to 2½ hours in an afternoon (see table 1).

Rates of downpour or intensities, measured in inches per hour, such as 4.3, 5.2, and 5.5 inches during 5 minutes or 2.32, 2.60, and even 2.92 inches per hour during 30 minutes, are reached by these rains. For the entire period of falling rain the average intensities are 0.6, 0.7, 0.8, and 0.9 inch an hour.

Storms causing run-off average between 9 and 10 a month for 8 months, from April to November, inclusive. From December through March the average is only 3 such storms.

The high intensities of these rains influence greatly the amounts of run-off from areas devoid of or almost without vegetation. The coefficient of correlation between the average rates of water run-off from two

nonvegetated desurfaced plots and average intensities of falling rain from 60 storms is 0.81 ± 0.044 . Thus 65.59 percent of the variance existing between rates of run-off may be explained by differences in average intensities of rainfall when no differences exist in degrees of slope, vegetation, or soils. Therefore, in considering erosion protection for any given area in Puerto Rico, it is obvious that we must consider means of guarding against these high intensities or the force of these rains.

Where this protection is not supplied as on non-vegetated areas, erosion may be so severe as to cause a loss of 1.95 or 2.54 inches of surface soil in 19 months. This applies to the fallow and the desurfaced duplicate plots. The losses are equivalent to 2.194 and 3.009 tons of soil eroded per acre per each inch of rain causing run-off. Water run-off from the same plots amounted to 31.8 and 38.1 percent of the rainfall. Differences between the two sets of duplicates might be attributed to the presence of organic matter in the topsoil of the fallow plots and its scarcity in the surface of the desurfaced plots, and to an average slope difference of 6.7 percent in favor of the desurfaced plot. The average slope of the fallow plots is 40.08 percent while that of the desurfaced plots is 46.80 percent. See table 2.

Squash plots lost as run-off 26.98 percent of their rainwater and 0.705 ton of soil eroded per acre per inch of rain. This suggests a canopy effect of the leaves acting as a buffer against the falling rain with little protection afforded against the flowing water.

TABLE 2.—Relation of plant cover to the control of erosion and run-off averages. Data from 1/70-acre duplicate plots on Catalina soil having slopes of 35 to 42 percent. (U. S. Department of Agriculture, Soil Conservation Service, Research Station, Mayaguez, P. R.)

Surface treatment	Period data were obtained	Rain causing run-off	Soil eroded			Water run-off		
			Per acre	From surface	Per acre per inch of rain	Per acre	Depth	Loss of rainfall
		Inches	Pounds	Inches	Tons	Cubic feet	Inches	Percent
Desurfaced ¹	June 1, 1938-Dec. 31, 1939	113.64	683,901	2.541	3.009	157,197	43.269	38.08
Fallow ²	June 1, 1938-Dec. 31, 1939	113.64	498,693	1.950	2.194	131,370	36.160	31.82
Sugarcane (holes) ³	Oct. 23, 1938-Dec. 31, 1939	75.12	38,432	0.153	0.258	27,534	7.379	10.09
Sugarcane (furrows) ⁴	Aug. 20, 1938-Dec. 31, 1939	93.52	3,275	0.013	0.018	14,737	4.057	4.34
Sweet potatoes ⁵	June 1, 1938-Dec. 7, 1938	44.94	6,463	0.024	0.072	5,106	1.405	3.13
Jackbeans and field beans ⁶	Dec. 8, 1938-Aug. 1, 1939	40.36	21,926	0.084	0.272	11,541	3.177	7.87
Squash ⁷	Aug. 1, 1939-Dec. 31, 1939	28.34	39,951	0.152	0.705	27,775	7.645	26.98
Molasses grass ⁸	June 1, 1938-Dec. 31, 1939	112.28	2,057	0.008	0.009	43,369	11.938	10.63
Bermuda grass.....	June 1, 1938-Dec. 31, 1939	113.64	1,648	0.007	0.007	36,255	9.979	8.78
Guinea grass.....	June 1, 1938-Dec. 31, 1939	113.64	2,787	0.011	0.012	50,448	13.886	12.22
Sour paspalum grass.....	June 1, 1938-Dec. 31, 1939	112.28	433	0.002	0.002	14,556	4.007	3.57
Green cohitre ⁹	June 1, 1938-Oct. 21, 1938	37.26	299	0.001	0.004	2,729	0.751	2.02

¹ The surface 2 feet of soil removed with the exposed soil kept bare of vegetation.

² Surface soil kept bare of vegetation and not cultivated.

³ Sugarcane planted Oct. 22, 1938, by cuttings at each corner of 4-inch deep, 2-by-2-foot holes which are in parallel columns and lines 2 feet apart each way.

⁴ Sugarcane planted Aug. 20, 1938, by cuttings planted 8 inches apart in contour furrows which were 3.5 feet between centers and 8 inches deep.

⁵ Sweet potato slips planted May 2, 1938, and followed by jackbeans Dec. 8, 1938.

⁶ Jackbeans planted Dec. 8, 1938, and cut June 6, 1939. Field beans had been planted in them May 11.

⁷ Squash were planted Aug. 1 and replanted Aug. 7, 1939, following the field bean harvesting on Aug. 1, 1939.

⁸ Poor stand on one molasses grass duplicate until October 1938.

⁹ Green cohitre planted Sept. 16, 1937, followed by sugarcane in holes October 1938.

Sweet potatoes planted May 2 and harvested December 7, 1938, permitted only 3.13 percent of their rain to run off, with an erosion of 0.072 ton of soil per acre per inch of rainfall. In contrast, and following these on the same plots, jackbeans and field beans between December 8, 1938, and August 1, 1939, lost as run-off 7.87 percent of their rainfall and 0.272 ton of soil eroded per acre per inch of rain.

Water run-offs from Guinea and molasses grasses, as judged by percent of rainfall, were greater than from any of the cultivated crops such as cane, beans, or sweet potatoes. Water run-offs and soil lost from sour paspalum grass and green cohitre were negligible.

Sugarcane when planted in holes, an old method of hillculture, permitted during 14 months an average of 10.09 percent of the rain to run off and 0.258 ton of soil to be eroded per acre per inch of rain. Only 4.34 percent of rainfall and 0.018 ton of soil an acre per inch of rain were lost during 16 months by cane planted in furrows following the contour of the land. This is a saving by the contour furrows of 0.24 ton per acre per inch of rain, or 15.84 tons an acre, for the 66 inches of rain causing run-off in 1939. Thus the cane in contour furrows retained 0.11 inch of soil more than the cane in holes. As 4 inches represents the average depth of topsoil in the hills for similar slopes, this saving is significant.

Sugarcane in contour furrows was planted August 20, 1938, by cuttings at an angle of 37° and 8 inches apart. The furrows were 3.5 feet apart between centers and 6 inches deep. That in holes was planted October 22, 1938, by cuttings, at each corner of 2-by-2-foot holes that were 4 inches deep and arranged

in parallel columns and lines 2 feet apart each way.

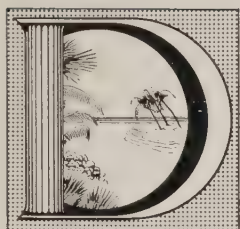
The average slope of the plots having holes is 45.6 percent while that of the contour furrows is 42.3 percent. By August 1, 1939, the total calculated water-holding capacity for all the holes in a 1/70-acre plot was only 0.4 cubic feet, while that of all contour furrows was 7.5 cubic feet. The average saturation requirement for the first 12 inches of soil on the contour-furrowed plots was found to be 0.52 inch in November 1938, while that of the plots with holes was 0.48 inch.

The surface area shaded by the foliage at noon on August 1, 1939, was 56 percent for the holed and 85 percent for the contour-furrowed plots. Shaded areas may be considered as a guide to the rainfall interception formed by the foliage. Bare ground exposed on the former was 83 percent of the total surface, while only 50 percent of the contour-furrowed plots was exposed to washing. The contour-furrowed plots retained 5.75 percent more of the rainfall than did the holed plots. This was equivalent to an average difference of 16 cubic feet a month for 14 months in favor of the contour furrows.

On January 16, 1939, 26,600 marketable stalks per acre were estimated to be on the plots with holes, with 24,500 per acre on the contour-furrowed plots. The former canes averaged 70.26 inches in length and 1 3/8 inches in diameter. The average stalk from the contour furrows was 85.82 inches long and 1 1/2 inches in diameter. Seed cane and tops are not included in these measurements. The yield per acre of the contour furrows was 57.69 tons while that from the holes was 29.51 tons. The cane in contour furrows thus produced 95.49 percent more than the cane in holes.

PASTURES IN PUERTO RICO

By H. W. ALBERTS ¹



URING the century just past there has been a profound change in the percentage of land utilized for pasture in Puerto Rico. As late as 1828 only 3 percent of the total area of land was under cultivation, with 24

percent in pasture and the remainder still in forest, brush, and swamp land. At the close of the century the cultivated area was increased to 12 percent and the pasture area to more than 50 percent. For several decades during this period there was a considerable export trade in livestock, hides, and tallow. Some of the best productive areas were in pasture. In 1905 the area in pasture was 57 percent. With the development of sugarcane, tobacco, citrus, and pineapple culture, great inroads were made on the pasture lands; they were pushed to the poorer and more rugged areas formerly occupied by forests. Export in animals and animal products ceased entirely.

The changes in land use are shown in the table. Data were obtained from the United States Department of Agriculture, Department Bulletin No. 354, "Forests of Porto Rico," by Louis S. Murphy, and from the United States Census of 1935.

Table showing land use in Puerto Rico in four periods

Land use	Percent of total area			
	1828	1900	1912	1935
	Percent	Percent	Percent	Percent
Cultivation.....	3	12	23	39
Pasture.....	24	52	47	36
Timber, brush, swamp, public, and other use.....	73	36	30	25

During the past quarter of a century the area of cultivated land was doubled again; it encroached upon the pasture land and reduced it to the extent of about 35 percent of its peak acreage.

Nearly all the land of the island is potential pasture land. Palatable native grasses thrive wherever the forests have been removed. Owing to the density of population, nearly all the land has been planted to crops at one time or another, even the steep hillsides where the soil is shallow and subject to severe erosion. Most of the hillside lands formerly were subjected to primitive agricultural practices. The forest trees were

felled and set on fire. Sometimes the larger ones were killed by girdling and left standing. Beans, bananas, corn, rice, yautias, and other crops were planted on the burnt-over areas where the ashes had enriched and sweetened the soil. Little cultivation was given these crops and the cropping seldom continued for more than 3 years. Eventually, as the fertility of the soil decreased and the surface soil was lost by erosion, and as grasses and other volunteer vegetation got the upper hand, the area was abandoned and a new clearing was made. This practice is quite rare now, as the population is so dense that it is necessary to raise crops on all available land.

In some hilly areas where commercial crops, such as tobacco, sugarcane, pineapples, cotton, and corn are produced on a larger scale, and where crops are produced primarily for household use, the land is left idle for a considerable length of time during the intercropping period. Such fields are soon covered with volunteer vegetation consisting mainly of grasses. If the farmers keep livestock the area is utilized for temporary pasture during this period.

Near the larger centers of population where numerous dairy herds are kept by farmers, the cows are provided with pasturage supplemented by green feed. The size of the pastures and the quality of feed in the pasture vary considerably. The area used for pasture by some dairy farmers is so small that it is only an exercising lot, while other farmers have large areas of meadow lands of native grasses or lands that have been planted for pasture purposes to guinea grass. Some farmers rotate their pasture lands with sugarcane and other crops.

On the south side of the island where cattle for work oxen are bred and raised, and on the north side of the island in the sandy coastal region near Arecibo where dairy animals are kept, the pasturage consists mainly of planted guinea grass.

The work animals are pastured until the beginning of the harvest of sugarcane. During the entire harvest period they are fed on cane leaves. After the close of the harvest season they are pastured again, and when feed in the lowlands is scanty some are taken to woodland pastures higher up in the mountains.

Woodland pastures usually are found on lands too poor or too steep for cultivation. The number of trees on such areas is decidedly variable and ranges from a

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few to many trees per acre. Areas that are too densely forested yield little pasturage.

Although wet lowland areas usually are covered with a dense growth of grass they are not pastured during the wet season because of the presence of foot and intestinal parasites. During the dry season, when the surface soil is firm and not saturated with water, such areas can be pastured.

The carrying capacity of good pastures is approximately one cow on 3 acres. Little care is given old pasture lands except that when unpalatable plants which have invaded the areas become too numerous they are cut with a machete. Some of the most common weedy plants that infest pastures are morivivi (*Mimosa pudica*), Santa Maria (*Vernonia albicaulis*), hedionda (*Ditremexa occidentalis*) and aroma (*Acacia farnesiana*).

Native Pasture Grasses

The species of grasses that are found in native pastures vary mainly with the soil moisture. Other factors that affect their distribution are soil types, soil fertility, and tillage.

Wet lowland grasses.—On wet lowlands subject to frequent periodic floods and where the ground is wet almost throughout the year, ricegrass (*Leersia hexandra*) thrives well. Areas that are occupied by this species of grass can be pastured during the short dry season. Para grass (*Panicum purpurascens*) and Caribgrass (*Eriochloa polystachya*) thrive in similar although somewhat drier situations. Their herbage is succulent and palatable. Both species are cut extensively for feeding in the green state.

Moist lowland grasses.—Moist lowland that is less subject to floods is usually occupied by carpet grass (*Axonopus compressus*) and mission grass (*Paspalum conjugatum*). Some farmers have large fields, resembling meadows, comprised of these grasses. Dairy cattle for city milk production usually are pastured on such lands.

Moist upland grasses.—Old, moist and well-drained upland pastures have St. Augustine grass (*Stenotaphrum secundatum*) as the dominating species. If the pastures have been established only recently they usually have a mixture of smut grass (*Sporobolus indicus*), *Paspalum conjugatum* and Bahia grass (*Paspalum notatum*) on the ridges, and carpet grass (*Axonopus compressus*) in the valleys and depressions.

Dry upland grasses.—The most common grass found in dryland areas is *Sporobolus indicus*. This species is tolerant to a wide range of conditions and is more widely distributed over the island than any other.

Among the other dry-land species of grasses are Bermuda grass (*Cynodon dactylon*), grama (*Bouteloua heterostega*), buffel grass (*Pennisetum ciliare*), *Chloris inflata*, sourgrass (*Trichachne insularis*) and *Andropogon virgatus*.

Bermuda grass (*Cynodon dactylon*) is found as a weed in cultivated crop lands throughout the island. It is used to a limited extent as a pasture grass on the northern sandy coastal plain west of Arecibo. *Bouteloua heterostega* is found in dry upland areas on the south side of the island. It is drought resistant and goes into a dormant state during the dry season. It is said to be less palatable than *Sporobolus indicus*.

Pennisetum ciliare is found in the dry lowland region from Salinas to Ponce. It is resistant to drought and constitutes the main native pasture grass of this part of the island. *Chloris inflata* is used for pasture on dry lowlands on the south side of the island. It requires more moisture for its development than *Bouteloua heterostega*. Sourgrass (*Trichachne insularis*) is low in palatability. Cattle will not eat it as long as other species are available. During the latter part of the droughty period, cattle graze it in the eastern part of the island. *Andropogon virgatus* is grazed as a pasture grass on the southern hilly areas of the island when no other pasture forage is available. The grass is low in palatability and is not grazed while it is green. During periods of extreme drought the cattle will feed on it to keep from starving.

Volunteer grasses on lands during the intercropping period.—These grasses consist mainly of annuals that appear soon after completion of intertillage of such crops as sweet potatoes, beans, corn, and yautias. Although the forage that is produced is not abundant, utilization of these grasses as temporary pastures is common.

Pasture Supplements

Supplementary pasture grasses consist of two classes: (1) Those that are planted to be cut for green feed and, (2) those that grow wild and are cut wherever they may happen to be found. The first class of grasses must compete with tilled crops, while the second class is obtained from idle lands or along roadsides. The first class may be subdivided into two groups as follows: (a) Those species that are planted solely for the purpose of cutting and feeding and, (b) those which may be planted for cutting and feeding green and which may also be used for pasturage. Other pasture supplements consist mainly of sugarcane tops and leaves, silage, and concentrates imported from the States.

Grasses planted only for cutting and feeding green.—Three kinds are used for this purpose—Merker grass, elephant grass, and Guatemala grass. All these require a fertile soil with abundant rainfall for their optimal development. They can be cut from 4 to 6 times a year depending on the stage of maturity at which they are fed. They cannot withstand continuous grazing or trampling.

Merker grass and elephant grass are varieties of the same species, *Pennisetum purpureum*. In general, farmers in the eastern part of the island prefer Merker grass while those in the western part of the island prefer elephant grass. There is a slight difference between the two in field performance: Merker grass matures earlier, is shorter than elephant grass under similar soil conditions, has more white bloom on the culms, becomes fibrous sooner, has thinner stems and if cut at the optimal feeding stages it may be cut oftener than elephant grass. Merker grass is also more resistant to Helminthosporium disease. Elephant grass is more widely distributed throughout the island than Merker. The cultural practices are the same for both varieties. The land is plowed and left fallow for about 2 weeks. It is then replowed and harrowed. Parallel trenches about 2½ feet apart and 4 to 6 inches deep are then made across the field. The cuttings are then laid on one side of the trench so that when the trench is again filled with soil one node is above the ground and at least two nodes are beneath the surface. The field should be weeded once after planting. No further cultivation is necessary. After a period of 3 months the first cutting can be made. Subsequent cuttings will produce higher yields because the plants stool profusely.

Guatemala grass (*Tripsacum laxum*) is propagated by planting cuttings or clump divisions. I have not found viable seed in Puerto Rico. The inflorescence is formed during the month of December. At the time when the stigmas have emerged and the ovaries are receptive the stamens are aborted and do not produce viable pollen. Although cuttings may be used in establishing a stand, better success is obtained by planting clump divisions.

Grasses planted for feeding green and for pasture.—The two species in this group are guinea grass (*Panicum maximum*) and malojillo, the Puerto Rican common name for Para grass (*P. purpurascens*). The cultural practices for guinea grass is similar to that of Guatemala grass, except that in guinea grass plantings the weeds are removed from among the plants until they reach the blossoming period.

The cultural practices for malojillo are similar to

those for Merker and elephant grass, except that longer culms are used and the planting must be done when the soil is moist. Malojillo has a hollow stem and is more subject to injury by desiccation.

Grasses not planted but cut and fed green.—The most desirable species are malojillo and guinea grass that may happen to grow in ungrazed abandoned fields or along roadsides. If these species are not available goosegrass (*Eleusine indica*), *Paspalum plicatulum* or other palatable species are used.

Sugarcane tops.—During the sugarcane harvesting season, on the southern side of the island, cattle are fed almost entirely on the sugarcane tops. Pastures are short during this time due to the small amount of rainfall.

Establishment of Pastures

Two methods are used in establishing pastures: (1) Cultivated fields are abandoned and allowed to grow up to volunteer vegetation, or (2) the land is prepared by plowing and harrowing, and is then seeded or planted with the definite intention of establishing a pasture.

Tilled lands that are abandoned are soon covered with vegetation, most of which consists of various species of annual grasses. There are several stages of succession of species, with one stage gradually merging into the next. For example, on the north side of the island the first stage occurs during the last months of the cropping period, before the crop is harvested. It is characterized by the appearance of short-lived annuals consisting mainly of red sprangletop (*Leptochloa filiformis*), jungle-rice (*Echinochloa colonum*), and everlasting grass (*Eriochloa punctata*). After the crop has been harvested the second stage appears; its main species are the crabgrass (*Digitaria horizontalis*), goosegrass (*Eleusine indica*) and sometimes knotroot bristlegrass (*Setaria geniculata*). The third stage appears about 2 or 3 months after harvesting and is characterized by the presence of *Paspalum conjugatum*, carpet grass (*Axonopus compressus*) and zacaton (*Andropogon bicornis*). The fourth stage, which appears several years after abandonment, is characterized by the dominance of *Sporobolus indicus*, St. Augustine grass (*Stenotaphrum secundatum*) and Bahia grass (*Paspalum notatum*). Grazing plays an important part in the succession; development of the palatable species is retarded while that of the less palatable ones is enhanced.

In some sections on the south side of the island the first stage of succession consists of redtop millet (*Panicum adspersum*). The intermediate stages con-

sist mainly of gazon (*Paspalum fimbriatum*), crowfoot grass (*Dactyloctenium aegyptium*), and *Sporobolus indicus*. The final stage, as found in old pastures, consists of *Sporobolus indicus*, *Andropogon virgatus* and *Bouteloua heterostega*, with the last-named species dominating.

Some pastures are established by sowing the seed of grasses. Owing to the continuous vegetative growth of tropical pasture grasses, the seeds must be collected by hand, at a time when the largest proportion in the inflorescence is mature. Many seeds are therefore immature, and the germination is comparatively low. The seeds of only a few species are utilized, among them molasses grass (*Melinis minutiflora*), and guinea grass (*Panicum maximum*).

The seedbed for molasses grass can be prepared at any time of the year but the best time is during the dry season, provided the soil is not too hard for plowing or too lumpy to make a fine smooth seedbed. Preparing the land during the dry season reduces the weed growth. Soon after the seedbed has been prepared the seeds are sown on top of the ground. The first rains will cover them to a sufficient depth. After 4 months from seeding the area is ready for pasturage. Owing to the peculiar molasses odor of the grass, cattle do not relish it at first, but after they are accustomed to it they thrive on it. Molasses grass tolerates poor soil, seasonal drought, and trampling by livestock. It is usually grown on poor hilly lands.

Guinea grass is the most valuable pasture grass in the dry sections of the island. It requires a more fertile soil than molasses grass. The land is plowed and left fallow for some time. The first plowing loosens the soil and subdues the vegetation although not completely. After about 2 weeks it is plowed a second time and then harrowed. Although it can be established by planting the seed, greater success is obtained by planting clump divisions of parent plants. These are set in rows about $2\frac{1}{2}$ feet apart, and $2\frac{1}{2}$ feet apart in the row. The space among the plants is cultivated or hoed until the inflorescence has formed. The field is then laid by, and the interspaces are seeded by self-sowing of shattered seeds from the established plants. Good stands are obtained also by sowing the seeds in corn after the last cultivation. After a period of about 3 months from the time of planting, the area is ready for pasture. Guinea grass thrives well on rich soils. It is resistant to drought and therefore forms the principle pasture grass on the south side of the islands.

Malojillo requires a more moist soil than guinea grass and therefore is more commonly planted for

pasture on the north side of the island where rainfall is more abundant. It is never propagated by planting the seed. The seedbed is prepared by double plowing; that is, a first plowing is made which is followed in about 2 weeks by a second plowing. Long parallel trenches about 4 to 6 inches deep and $2\frac{1}{2}$ feet apart are made across the field. Planting is done when the soil is moist. Stolons of about 4 feet in length are laid in the trenches so that the tips will be on the ridges and the remainder in the trenches. The part in the trenches is then covered with soil. Owing to its stolon-forming habit this grass soon covers the area. After the area is completely covered, stolon formation ceases and only erect culms are produced. The area is usually ready for pasture about 3 months from the time of planting.

Relation of Pastures to Soil Conservation

On well-managed pasture lands, soil formation and soil erosion approximately balance each other. Nearly all the surface soils on the island from a depth of a few inches to several feet, are extremely porous and have a high absorptive capacity for moisture. Below the surface layer the interspaces of the soil are filled with fine particles that are packed so firmly that they form an impervious layer similar to hardpan. Comparatively little water percolates through this layer; instead it gradually travels along the surface of this impervious layer below the porous topsoil to lower levels.

Although much rain falls in frequent intermittent showers, the period of duration of the showers usually is not longer than 10 or 15 minutes. The rainfall of most showers is absorbed almost completely by the spongy layer of surface soil, and consequently there is little or practically no surface run-off. When heavy showers of longer duration occur, the porous surface layer becomes supersaturated and the additional water runs off on the surface to lower levels, to form numerous deep finger gullies on tilled lands. Furthermore, owing to its great velocity as it runs down the slope, it carries large quantities of soil in suspension. It is estimated that 69 percent of the tilled land on the slopes of the island have lost more than 25 percent of their surface soils through erosion.

Pasture lands suffer comparatively little from soil erosion. Although less water is absorbed by the soil immediately following each shower because of the compactness of the surface layer that has not been loosened through tillage, there is comparatively little erosion after the soil has reached its point of satura-

(Continued on p. 23)



Sodding an outlet channel by hand. The man at the right is punching a hole where the clod of protecting grass is to be placed.

VEGETATIVE PROTECTION OF TERRACE OUTLET CHANNELS

By W. LÓPEZ DOMÍNGUEZ ¹



OUTLET CHANNELS in Puerto Rico should be protected with some form of vegetation, preferably a dense low-growing grass, to prevent them from eroding. The grasses to be used and also the planting methods vary in

different localities according to precipitation, soil type, and slope. Heavy rainfall may occur when the land is without a crop. Consequently the amount of water running in the channel may be very great and the risk of damage is increased. In such an instance solid sodding, the most effective means of protecting the channel, is needed.

The soil type of the channel under construction may be loose (of a sandy type) or may be compact (of a clayey type) and the method of vegetating must be adjusted accordingly. Sandy soils need more effective means of protection than the clayey soils. Four different methods of establishing vegetation have been used in the Mayaguez area: These are (1) solid sodding, (2) strip sodding, (3) sprigging, and (4) strip sodding and sprigging combined.

Solid sodding.—When this method is used a continuous cover of grass sod is transplanted over the entire bottom of the channel and about one foot of the channel sides. When enough grass is available solid sodding is recommended. In the Mayaguez demon-

stration area it has been used in channels constructed on slopes of more than 40 percent with estimated velocities exceeding 8 cubic feet per second. Some of these channels were constructed during the rainy season, and the run-off water had to be diverted to a temporary channel until all the vegetation had become established. In other places, however, wire netting was used to hold the sod.

The sod had to be dug by hand with long-handled spades, as there was no sod-cutting machine available. We think, however, that it is unlikely that a sod cutter will work in most of the areas in Puerto Rico, as there are practically no large areas of flat pasture land in the interior of the island where most of the solid sodding is being done.

The results obtained in more than 25 solid-sodded channels were very satisfactory: In more than 90 percent of them erosion of channel bottoms was prevented even when the rain intensities, several times recorded, were over 3 inches per hour for a 5-minute period.

Strip sodding.—This system involves trenches dug across the channel with a definite vertical interval. Care must be taken that the trenches are cut to the dimensions of the sod blocks, so that they fit in flush with the bottom of the channel.

In the beginning of our work we were using strip sodding in channels constructed on slopes of more than 20 percent, but we noticed that small overflows developed below each strip of sod. This showed us that strip sodding may not be recommended for chan-

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nels constructed on steep slopes and should be used only in places where scarcity of grass makes it difficult to obtain enough for solid sodding.

Sprigging.—Sprigs are planted in small holes about 1½ inches in diameter and 2 inches deep, usually made with an iron bar, or with a sharp-pointed stake and a hammer, in the bottom and sides of the channel. The holes should be spaced about 8 inches apart each way and staggered. In order that the sprig will have a good start, the hole must be filled with a mixture of good topsoil, “cachaza” (a sugar mill byproduct) and mixed fertilizer.

The slopes where sprigging is used to advantage are not steep ones. The method is economical and the channel bottom will be covered very rapidly, especially if Bermuda grass is used.

Strip sodding and sprigging combined.—We noticed that small overfalls developed below the strips of sod, and to correct this the eroded places between the strips were filled with soil which was tamped and sprigged with the same kind of grass as that growing in the strips. By this method coverage of the channel was accomplished more rapidly than where strips alone were used, and there was less erosion between strips. Where sod is scarce, strip sodding may be used satisfactorily on steep slopes, providing the spaces between the strips are treated with sprigs. However, this is not to be recommended for use in channels with slopes exceeding 25 percent.

Most of the grasses that have been tested in the Mayaguez area are proving satisfactory for soil-erosion control and vegetative protection of outlet channels. Among those already tested are Bermuda, centipede, and carpet grass.

Bermuda is a rapid-growing grass during rainy periods, but when a dry period starts, it suffers greatly from lack of water. It does not thrive in shade. It is recommended for use in sprigging because of its rapid growth under favorable conditions.

Centipede grass is slow growing and is especially adapted to a shady, moist condition. Good results were obtained from solid sodding with this grass. When planted during dry periods mulch can be used to advantage. Sprigging with this grass should be avoided because of its slow growth. If sufficient centipede grass is not available for solid sodding, chunks of sod about 2½ inches in diameter may be used; they must be watered and covered with mulch. Once established, centipede grass, because of its low growth and dense cover, is one of the best species.

Carpet grass does better in shady and humid locations than any of the other grasses tested. It is

scarce in the lowlands, however, while in the highlands it is abundant. Its use in dry locations should be avoided. It has a low growth habit and should not be stimulated to tall growth by use of too much fertilizer. It should be kept in mind that when the channel is treated, the sides must also be protected. Mainly, we use the sprigging method.

RIO GRANDE DE LA PLATA

(Continued from p. 11)

channel-type terrace is recommended for water interception and diversion and as a guide for contour tillage. A variable channel gradient, and a vertical spacing dependent on slope to a maximum 6-foot spacing, are used in layout work. The main objection to this method of terracing is the inevitable problem of satisfactory maintenance, as in the Cayey area there are no suitable plows for proper plowing.

Group 8.—In this group are all riverwash soils near streams for which only native pasture can be recommended because of subjection of such areas to overflow by the streams. Where streambanks are likely to slough and cut back, bamboo plantings on the contour are stipulated for protection.

Strip cropping is recommended where practicable on all cultivated slopes, with alternate bands of clean-cultivated row crops and thick-growing crops to eliminate overloads of surplus water and soil flow on barriers and other structures. Peculiar to Puerto Rico is the fact that thorough utilization of the land necessitates the use of food cash-producing crops, whether clean-tilled or close-growing in the strip cropping system. There is little likelihood of satisfactory adaptation of purely green-manure or leguminous crops in the agriculture on subsistence farms of the size held by resettlers. Sodded concentration, or outlet channels, are essential in bench formation and channel-type terraces for disposal of surplus surface water. Crown cultivation only is recommended for bananas, plantains, and fruit trees, with undisturbed areas left between plants and tree.

Individual bench terraces for grove plantings of fruit trees are being used and recommended. The plantings are contourwise; i. e., all benches on a row of trees are level or on the same contour. Up and down the slope, the individual benches are staggered. Each tree occupies the center of an individual bench terrace which extends radially from the tree, approximately horizontally, for at least 2½ feet. Crown cultivation is stipulated, and the area between benches is recommended to remain well covered with cover crops or native vegetation.



Panoramic view of tillage experiment on bench terraces. To determine effects on drainage, plots with ridging in various directions are being prepared. This Puerto Rican type of bench terrace provides drainage by having a higher outer edge and a low grade at the inner edge, along which the water is carried to a sodded outlet.

TILLAGE TESTS ON BENCH TERRACES OF MUCARA CLAY

By ROBERT L. DAVIS¹

BENCH terracing has been advocated as a method of controlling erosion on steep cultivated slopes in Puerto Rico. The bench terrace of Peru and the East Indies has a low dike built along the outer edge to facilitate irrigation and protect the banks, but the type used in Puerto Rico² differs in that it was designed to meet requirements in the island where one of the main problems is drainage. In the Puerto Rican bench terrace no dike is used, but the outer edge is somewhat higher than the inner edge and thus drainage is ensured and water is prevented from running over the terrace bank. An open ditch along the flow line, or inner edge of the terrace, drains the water into a sodded outlet channel. As it was early apparent that no literature was available on suitable methods of cultivation on bench terraces of the Puerto Rican type, tillage tests were initiated and carried out to secure the data needed. This article describes these tests.

A 1-acre field of bench terraces on Mucara clay with a slope range of 20 to 35 percent was selected for trial. As originally constructed the terraces had a

vertical interval of 4.5 feet and a grade of 3 inches per 100 feet. They did not drain well, however, apparently because no provision had been made to increase the carrying capacity of the terrace at the narrow places. This defect was corrected in October 1938, by increasing the greater height of the outer edge of the terrace to 12 inches. It resulted in a back slope of about 4 percent at the broad places and 10 percent at the narrow places.

Three directions of ridging designed to facilitate drainage and check erosion were compared with flat cultivation. The tests involved ridges parallel to the outer edge of the terrace, and ridges at 10° and 45° angles to the inner edge of the terrace. The photograph illustrates the Puerto Rican type of bench terrace and shows ridges being constructed at various directions to determine their effect on drainage and on holding soil moisture. The plots varied considerably in size because of the variable width of the terrace bench, but they averaged one twenty-fifth acre in area. There were five plots of each treatment and one of each treatment was located on each terrace.

All ridgings reduced the row slope and thus tended to hold the water on the terrace benches. A ditch at right angles to the terrace bank was provided at the

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² Designed in August 1936 by George L. Crawford.

Soil moisture percentages and corn yields in tillage tests on 25- to 35- percent slopes of Mucara clay at Mayaguez, P. R.

Cultivation practice	Plot group numbers					Average moisture	Average ** yield of corn
	1	2	3	4	5		
	Soil * moisture	Soil moisture	Soil moisture	Soil moisture	Soil moisture		
	Percent	Percent	Percent	Percent	Percent	Percent	Bushels
Flat cultivation	29.01	33.92	31.79	27.47	32.00	30.84±2.08	52.78± 6.31
Ridges parallel to terrace crown	31.12	34.38	26.75	28.54	32.89	30.74±2.47	55.79±12.90
Ridges at 45° angle to the flow line	28.74	33.00	38.50	31.58	31.60	32.68±2.45	58.80±11.12
Ridges at 10° angle to the flow line	26.48	29.31	28.51	27.95	28.08	28.06± .68	65.36±18.71

* Moisture determinations are based on a composite soil sample from 5 borings per plot, made to a depth of 6 inches on the westward sides of the ridges, 4 feet from the outer edge of the terrace and halfway between adjacent hills of corn.

** Yields of air-dry shelled corn are based on harvests of 1/100-acre areas taken from each plot. The yields given are those of the actual area occupied by the corn, not including the terrace bank. The corn was harvested by L. Valdespino and Juan Pérez, of the Puerto Rico Reconstruction Administration.

lower end of each plot to prevent drainage of any plot from affecting adjoining plots. When ridges parallel to the flow line are used on terraces several hundred feet long, ditches of this kind are essential to prevent too much water from accumulating during rainy periods.

With the object of securing economy in land use, all ridges were spaced 2 feet apart. Where the terrace width did not permit of an even division, wider spacing would have resulted in considerable unused land at the edges. Plantings were made on the westward side of the ridges so that they would be protected against the drying effect of the prevailing wind and the morning sun. They were placed halfway down the ridge in order that the plants might be on the same level as those grown on the plots given flat cultivation.

Although plot sizes were not large enough to give full advantage in using the plow, sharp contrasts were noted in cost of land preparation and cultivation. Since the ridges at the 45° angle to the flow lines were very short they were constructed by hand at a cost of \$16.32 per acre, which is probably prohibitive for subsistence crops. The other ridges were plowed out with a mule and 7-inch hillside plow, and the only handwork was that done in opening up the lower ends of the furrows. The construction of those parallel to the outer edge cost \$5.94 per acre, while those at the 10° angle to the flow line cost \$3.20. The accurate spacing of the ridges, which would not be necessary under ordinary farm conditions, ran up costs unduly for the ridges parallel to the outer edge; ordinarily they would cost less than those made at 10° angles, as there would be fewer furrow ends to finish by hand.

All ridging apparently reduced soil loss. In plots without ridges the water drained off rapidly and was observed after the heavier rains running in small streams almost straight down the slope to the inner edge of the terrace. In plots with ridges the planting

furrows were often full of water for some minutes after rain had stopped. Ridges at a 45° angle to the flow line reduced the drainage slope but slightly, and there appeared to be more rapid silting in the lower ends of the furrows than on the plots where the more gently sloping ridges were used. Drainage was good on all plots, and within an hour after rain practically no standing water was observed.

A severe winter drought resulted in depleted stands of all plantings made in the fall of 1938. In April 1939, the ridges were restored to their original height by hoeing and were planted to field corn. The hills were 3 feet apart in the row and the corn was thinned down to two plants to the hill, thus allowing 3 square feet per plant. Conditions were favorable and an almost perfect stand was secured. Acre rates of fertilizer applications amounted to 600 pounds of the formula 8-14-4 (ammonium sulphate, calcium super-phosphate, and potassium sulphate), placed in the hills at planting time and an additional side dressing of 150 pounds of ammonium sulphate just before tasseling. The mixed fertilizer alone apparently was ample, as the corn had healthy dark green leaves and grew well over 8 feet in height, except on a few spots on the steeper slopes.

The weeding cost of plots given flat cultivation was lower, averaging \$6.71 per acre—this because there was no ridging to interfere with the work of the mule. Plots with ridges parallel to the outer edge, the only others given mule cultivation, cost \$7.75 per acre. Because of the risk of destroying corn plants when turning, mule cultivation could not be used on the rows at 10° or 45° angles to the flow line, and costs were therefore high, \$8.60 and \$9.16 per acre, respectively.

In studying the effect of ridging on holding soil moisture, determinations were made when the corn was about a month old and toward the end of a rather severe drought. These determinations are shown in

the table. The moisture in plots having ridges parallel to the terrace crown averaged 30.74 percent and in four of five comparisons was higher than in those given flat cultivation or those with ridges at a 10° angle. The moisture percentage averaged highest in plots having the ridges at a 45° angle, but this was because of the unusually moist condition of one plot at the lower end of one terrace. These results indicate that contour ridging on bench terraces might play an important part in ensuring good yields from fall plantings maturing in early winter when severe protracted drought is normal.

When the uncultivated areas of the terrace banks are included in the calculations, the average yield per acre was 43.2 bushels of shelled corn. This is the maximum yield reported for field corn in the Mayaguez district, except on small experimental plots. Fifteen bushels on untterraced upland slopes and 35 bushels on fertile lowlands represent good yields. The field used had been badly overgrazed and abandoned prior to terracing. The results indicate that bench terracing and heavy applications of fertilizer may reclaim land of this type and make it productive.

Plot yields as shown in the table were variable, and tillage treatments did not give significant yield increases over flat cultivation. If the drought that occurred when the corn was young had been more severe, the moisture-holding capacity of the ridging probably would have affected yields. The data represent yields or actual areas occupied by the corn, excluding that of the terrace bank.

Bench terrace construction usually exposes barren subsoil along the inner edges of the terrace near the base of the bank. To determine the extent to which

soil building is needed, harvests were made at various distances from the terrace bank. In seven out of ten comparisons, corn grown 2 feet from the terrace bank yielded less than that grown at a distance of 4 feet. The average difference was over 8 bushels an acre. Contrasts were about as strong between yields at the 2-foot distance and those of 6- or 8-foot distances. There were no such yield differences between corn grown at 4-foot and that at 6- and 8-foot distances. This indicates the urgent need of green manure crops for soil close to the base of the terrace bank. Until it is rebuilt, this unproductive land which is about one-sixth of the cultivable area, may be considered as having been thrown out of cultivation by bench terracing.

Conclusions

Drainage was adequate on plots without ridging. This indicates that for drainage purposes the bench terrace design used is satisfactory and ridging unnecessary.

The use of ridging to conserve moisture may be desirable in fall cropping to minimize the effect of the winter's drought.

Cultivation costs are less with ridges parallel to the outer terrace edge than with ridges at 10° or 45° angles to the inner edge.

Construction costs for ridges at a 45° angle are probably prohibitive for subsistence crops.

Low corn yields 2 feet from the base of the terrace bank indicate the need for use of green manure crops.

The high average corn yield indicates that steep overgrazed slopes of the type used may be reclaimed by bench terracing and adequate application of fertilizer.

PASTURES IN PUERTO RICO

(Continued from p. 18)

tion. The closely interwoven fibrous root system of grasses in the surface soil, together with the herbage above the ground, spreads the surface run-off and prevents the formation of finger gullies. If water concentrates in slight depressions it is soon diverted and spread by other grass plants farther down the slope, thus reducing the velocity and allowing a large proportion to percolate into the soil as it moves slowly down the slope. Most of the silt that it may carry as it flows down the slope is held by grasses and grass residues farther down. The impact of the raindrops also loses most of its effect. The drops fall at high velocity on the vegetative part of the grasses and do not hit the soil directly. The surface soil particles are

not loosened as readily as they are where there is no vegetative covering.

Most grass roots are found near the surface, though a small percentage penetrate to lower levels. When some of the surface soil is lost by erosion, the roots which penetrate to lower levels aid in forming new soil underneath from parent soil materials, and this helps to balance the soil lost on the surface by erosion.

A single issue of SOIL CONSERVATION manifestly cannot give complete treatment to the land-use and erosion problems and programs of Puerto Rico. From time to time, as space permits, additional articles will be published pertaining to the island's soil conservation activities.—Editor.

USE AND LIMITATIONS OF TRASH BARRIERS

By ROBERT L. DAVIS ¹

THOUSANDS of acres on steep upland slopes in Puerto Rico are being cleared for cultivation. Much of this land is covered with trees and bushes or, occasionally, a dense growth of grass. It is common practice to burn all the trash, but a more satisfactory disposal is to place it along the lines surveyed for terraces so that it can be used to support the soil plowed or cultivated downhill. Any stones found in the field may be gathered and included in the barriers and, if there is not enough trash, vegetation may be used. In any event, it is essential that some binder plant that roots at the joints be present so that it will grow over the trash and hold it together. Otherwise, after about a year, the barriers will collapse in the places where decay is most rapid and the soil held above them will be washed down the slope.

The making of trash barriers is a simple process once the survey is completed, even where the land is in forest. The larger tree limbs are used for firewood or in making charcoal; the smaller ones are placed in position and then made into a fairly compact barrier by cutting from above with a machete. Any leaves or smaller bits of trash are placed directly above to catch the soil, and below the barrier an occasional stake is driven in for support; on the steeper slopes the stakes are placed close together, one about every 3 or 4 feet. Where time permits, the planting of pigeon peas or Guinea corn at the proper places would make staking unnecessary and, no doubt, would lower costs. The tree stumps that are difficult to remove may be left to be worked out as they decay, and in the meantime the plow may be passed around them.

When the trash consists mostly of small tree limbs and brush and is piled up 1 or 2 feet high, it may form a stiff enough barrier to hold the plowed soil during the first year or two, provided vegetation is used to bind it together.

The photograph illustrates this type of trash barrier below which wild beans (*Calopogonium coeruleum*) were planted. The wild beans have taken root at the joints and are binding together the decaying trash. Terrace banks about 2 feet high have formed in about 18 months. The bank is now approximately on a level with the top of the trash. After this, unless more trash of the same kind is added, the barrier no longer will support a plow furrow slice. It becomes necessary, therefore, to plant stiff-stemmed plants,

such as elephant grass, just above the barrier for the purpose of building the terrace bank still higher. If the plantings are not made and the plowman is careful not to throw the plowed soil directly against the trash barrier, but somewhat higher up the slope instead, the terrace bank will continue to form to a certain extent but will not be steep enough and will occupy too large a proportion of the land. Where there is not enough trash, the stiff-stemmed plants should be used from the very first.

In the case of hand cultivation the stiff trash barriers will hold the soil fairly well without stiff-stemmed plants, but as a rule there are two difficulties: It is not likely that the laborer will spread the soil uniformly or close enough to the barrier, to form a steep terrace bank; and furthermore, crop residues and other trash may not be spread uniformly next to the barrier so that breaks in the terrace bank will occur where the smaller amounts are placed. The use of the stiff-stemmed plants above the trash barrier tends to correct all this, as they provide a uniform obstruction that holds both soil and other accumulations all along the terrace line.

When the trash barrier is made of the ordinary kinds of native pasture grass, and consists largely of small weak stems and leaves, it is not rigid enough to support soil plowed against it. For this reason this kind of trash should not be used alone for constructing terraces; it can be used, however, in combination with stiff-stemmed forage grasses similar to elephant and Guatemala grass. Trash barriers of small weak stems can be used for making barrier terraces if construction work is done with care and by hand—that is, if the farm laborer very carefully hoes the dirt against the trash and takes great pains to form the right slope so that too much of the land will not be occupied by the terrace bank. This is an expensive procedure, however, and should be used only when the trash contains considerable amounts of living sprigs from grasses such as Bermuda and sour Paspalum which would take root in the soil and form a living protective cover. Care would be needed also in arranging sprigs uniformly along all the terrace banks. Should the trash consist entirely of dead material, it would be necessary to plant grasses of the above mentioned type in it ²; otherwise it would be certain to decay and the terrace

¹ Agronomist, Soil Conservation Service, U. S. Department of Agriculture, Mayaguez, P. R.

² Bermuda grass practically doubles cultivation costs, and should not be used in localities where it is not already prevalent.

bank, no longer protected, would be quickly destroyed by the heavy tropical rains.

Near Cayey, trash barriers containing living sprigs of Bermuda grass have been used extensively above hillside ditches. Where Bermuda grass was sufficiently prevalent, they were effective in filtering out the soil washed down the steep slopes between the ditches. Data gathered from similar slopes, or the same slope above one ditch, are given in the table. Where trash was available, or uniformly distributed above the ditch, soil accumulated to a depth about 6 to 14 inches greater than where trash was not used. With one exception, however, the bank slope was not steep enough for economical use of the land. On a good many farms in the same vicinity it was observed that the trash had been dried out and burned or, if retained, was not placed properly; this is but one example of the difficulties encountered in trying to instruct the farmers in the use of material of this kind. Stiff-stemmed plants, planted at about the time the ditches



*Barriers of leaves, brush and small limbs. Wild bean vines have taken root in the decayed trash.
Scene: The Marini farm near Mayaguez.*

were constructed and just below the trash, would have ensured better protection as well as better bank development.

It is apparent in Puerto Rico that in no case is it practical to use trash for barriers without living plants to hold it together as it decays. The use of stiff-stemmed barrier plants cannot be avoided unless all the work is done by hand, and this would require expensive supervision to ensure uniform development of the terrace bank.

Terrace bank formation resulting from use of trash above hillside ditches at Buena Vista farm in the Cayey area of the Soil Conservation Service

Number of resettler farm	Soil type	Slope percent- age	Direction of exposure	Cultivation practiced	Bank * slope per- centage	Bank height *	Trash disposal
		Percent			Percent	Inches	
33	Jacana.	27	Southern.	Plowed 3 times.	80.7	23.7	Trash raked off field.
** 38	Mucara.	30	do.	do.	121.4	30.2	Trash uniformly distributed.
32	do.	25	Northern.	Plowed 3 times and hoed twice.	90	22	No trash.
32	do.	25	do.	do.	118	39.2	Trash lined evenly.
40	Jacana.	28	Southern.	Plowed once and hoed twice.	119	28.4	No trash, banks badly eroded.
40	do.	28	do.	do.	165.8	36.8	Trash lined evenly and banks protected with Bermuda grass.

* Averages of 5 measurements in each case made with a clinometer and ruler. Data were gathered on September 8, 1939, by Carlos Archeval, agronomy aide of the Puerto Rico Reconstruction Administration.

** Most of the cut in resettler farm 38 consisted of parent rock material. The bank above the ditch was bare as trash was all dead and lacking in any stoloniferous plants.

AN ATTEMPT AT WATER SPREADING IN PUERTO RICO

By R. C. CLIFFORD ¹

TOWARD the center of the southern coast of Puerto Rico, more specifically around the town of Coamo, lies a great deal of country that is used for cattle raising. Here the land is mostly in pasture and although there are a few dairy farms the raising of beef and work cattle is the major industry.

Near the coast, the land flattens out into large plains on which the major crop of the island, sugarcane, is grown exclusively. Farther back, and some 7 or 8 miles towards the north, steeply sloping hills close off this part of the south coast from the rest of the island. The cane belt lying along the coast to a depth of 3 miles is irrigated from canals which convey water from two large reservoirs. Lying between the cane belt

and the lower hills of the range to the north is the pasture country. This land is in pasture merely because it cannot be reached by irrigation water and the rainfall is not sufficient to make cane farming a successful enterprise. The pasture land lies within a rain belt averaging 34 inches a year.

The general topography may be described as rolling with small isolated hills rising here and there. The slopes vary from 5 to 15 percent on about a fourth of the pasture lands; on about half the area the slopes range from 15 to 40 percent while on the remainder they are from 40 to 60 percent and more. The hills are very sparsely wooded and their lower slopes are planted to pasture grass. A few scattered farms, hanging to the hillsides, eke out a precarious existence.

¹ Engineer, in charge, soil conservation work at Coamo and Sabana Grande, P. R.

The soils of the pasture land on the lower slopes consist mostly of Coamo and Yauco clays to clay loams. Both these soils absorb water readily but they are well drained and have a semifriable subsoil.

Much of the pasture land has been planted to Guinea grass which, during the rainy period or more specifically from August to the end of November, grows almost high and dense enough to hide the pasturing animals. The grass is grazed while still green and until about the middle of March. This grass needs a great deal of moisture to keep it green and during the hot and dry summer months the pastures appear brown and burnt with no trace of Guinea grass showing. Should there be a dearth of moisture during the rainy period, the farmers lose many cattle; in the summer of 1938 one cattle farmer lost 80 head and another 72 head from lack of feed. The cattle farmers estimate that 3 acres of good pasture will carry one cow a year. It is their opinion that during the months when there is no Guinea grass, the native grass and weeds will carry the cattle over until the Guinea grass revives—that is, if the rains are normal.

Generally speaking, the rains in the hills exceed those that fall on the lower lands. With this in view, and with the purpose of utilizing the extra rainfall run-off from the hills, to augment the moisture on the lower and flatter lands, the Coamo water-spreading project was undertaken as a demonstration. The project area consists of about 80 acres, and as a demonstration area it is ideally situated; it lies along a paved and well-traveled highway which connects San Juan and Ponce, and is only about 3 miles from the town of Coamo. The area lies north of the highway and is bounded on the north and west by the lower slopes of hills that form part of the range to the north of the pasture lands. At one time this land was planted to cane but lack of moisture made cane farming unprofitable and it was converted to pasture. Tufts of Guinea grass were planted along the old cane furrows but without very good results, as Guinea grass density is only about 25 percent. Native wiregrass and small weeds constitute the major cover. The average slope is 5 percent over most of the area and the soil is a Coamo silty clay loam. The land is flat to gently rolling with two distinct drainageways which unite toward the lower end of the area and form a medium-sized gully. Run-off from the north is intercepted by a gully which runs between the hills and the area and parallels the north boundary fence, while the hills along the west boundary shed their run-off directly on to the pasture land. The gully to the north has a watershed area of 85 acres of steeply sloping, sparsely wooded

and well-grassed hilly land.

In computing the run-off the commonly accepted intensity for a 25-year period, 8 inches, was used with a run-off factor of 0.5, which gives an expectancy of 340 cubic feet per second. The normal amount of precipitation in this region is 3 inches, and this may be expected once or twice a year, generally following rains of lesser amount. The average rainfall and average run-off figures of the Coamo Reservoir report, covering a period of 30 years and made by the Puerto Rican Irrigation Service (south coast), show that the greatest run-off may be expected in the month of November. As these are the only figures available, they were used in computing the run-off that may be expected from the 85 acres of watershed. It was found that during November the run-off from a 3-inch rain would be approximately 10 acre-feet.

In order to utilize the water coming from the 85-acre watershed it was necessary to construct an earth dam and divert the water to the spreading ground. An earth dike, connected to the dam, conducts the water out across the upper portion of 30 acres of spreading ground. Placed in the dike are five weeps, through which the water is spilled on to the plain below the dike. A spreader has been placed at a vertical interval of 2 feet below each weep. These spreaders consist of two rows, 4 inches apart, of Merker grass. In constructing the spreaders, two parallel furrows were made and the soil thrown to the center was used as a seedbed. The spreaders are V-shaped and placed on a 0.4-percent grade. Other spreaders of Merker grass at 2-foot vertical spacings have been placed on a grade, and the water has been sirup-panned over the 30 acres lying below the dike.

The run-off from the hills lying to the west of the area also has been diverted from its original waterway by means of an earth dike and is now conducted to a fairly smooth spreading area. Weeps have been placed in this dike, with Merker grass spreaders below them. An attempt has been made to increase the density of the Guinea grass by plowing and seeding alternate interspreader spaces. The part of the area that cannot be reached by spreading has been furrowed on the contour. Four furrows have been made with ox-drawn plows at intervals of 2 feet vertically; these have been seeded to Guinea grass. The small gullies in which water might concentrate have been checked by four-row plantings of Merker grass placed crosswise of the gully. The checks are V-shaped so that they will not only check the flow but also divert it out of the gully. The V-arms extend for 25 feet on the banks.

(Continued on p. 30)

SOIL CONSERVATION IN SUGARCANE

By ROBERT E. WITHERELL ¹

ON THE second voyage of Columbus, sugarcane was brought to Hispaniola, or, as it is now called, the Dominican Republic. The first sugar was made in 1509. From this island as a center of distribution, cane soon reached Cuba, Puerto Rico, and other West Indies. The first sugar mill in Puerto Rico was established in 1524. All of these early movements of cane, both in Europe and in the Western Hemisphere, had to do with one single variety. This was a short-jointed, medium slender, greenish cane of poor tonnage, but with sweet juice and soft tissue that made it easy to mill and pleasant to chew. The early cane was replaced during the later years of the eighteenth century by better and more productive kinds. From this time on, the history of the cane-sugar industry becomes more and more a history of the introduction and distribution of cane varieties, such introduction usually being the result of an outbreak of disease that seriously threatened local industry.

A variety of cane known as Otaheite became an universal favorite and its extensive planting really marked the beginnings of the modern sugar industry. For many years after its introduction, this Otaheite cane continued to grow vigorously and yield abundantly. However, it was found after the first richness of the soil had been exhausted by continued plantings, or when plantings had been made on poorly adapted soils, that production was rapidly decreasing.

In 1872 a disease appeared in the Otaheite cane on the east coast of Puerto Rico. It so happened that the outbreak was first noted on the farm where the Federal Experiment Station is now located at Mayaguez. It soon spread until the western half of the island was involved. In the infected fields the cane was short and stunted and soon died. Here and there, scattered among the Otaheite variety were stools of Chrystalina cane and it was noted that they were but little affected by the disease so that this hardiest kind was chosen and the industry was restored.

Again in 1915 an unknown and mysterious disease appeared in the town of Arecibo and extended into the hilly section to the west of the town. Its effects on the cane caused a stunting of the growth while the leaves became mottled or chlorotic in appearance. It was considered as something new and was called in Spanish "matizado," the name by which it is still

generally known in Puerto Rico. The disease spread rapidly and in 1918 had invaded practically three-fourths of the sugar area of the island.

In August 1918, Prof. F. S. Earle was commissioned by the United States Department of Agriculture to go to Puerto Rico and investigate the disease, in cooperation with the Federal and Insular experiment stations. Important headway was made and the mysterious "yellow stripe" was found to be identical with the mosaic of Hawaii and the "Galestrepenziekte" of Java.

Up to this time the sugar production of Puerto Rico had not exceeded 500,000 tons, and it was believed that it would never again reach that figure. In 1919 it had fallen to less than 400,000 tons and there were practically no new lands to be brought into cultivation. As agricultural methods improved, by 1925, the presumably worn-out cane land was made to produce 660,000 tons. However, the methods of improvement consisted of new cane varieties and the increase in application of fertilizer with different formulas.

Improvement in the manufacturing side of production had gone forward rapidly, as had methods of transporting the cane to the mill. In recent years steam plows and gasoline tractors have been used more and more widely for preparing the lands, but the furrows with few exceptions still ran straight up and down the hill and little thought was given to channel design. The heavy rainfall during the planting season exacted its tremendous toll from the soil. No great thought had been given to erosion or soil loss, and it was not until 1936 when the Soil Conservation Service of the United States Department of Agriculture sent a small group of technicians to the island that one of the most important cultural changes slowly began to take place. With the cooperation of the Puerto Rico Reconstruction Administration funds were made available to carry out demonstration and research work in soil conservation practices.

Studies are now being made at the Soil Conservation Experiment Station at Mayaguez on the contour cultivation of sugarcane. At the demonstration areas located at Castañer and at Zalduondo Farm, Luquillo, comparisons are being made to determine, under field conditions, the advantages of contour furrowing and ridge terracing over the usual methods of cane planting.

At Zalduondo Farm, 4 acres were selected on slopes ranging from 5 percent to 33 percent on the poorest land in the area. The field was plowed and harrowed

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*Hillside ditches being constructed
by oxen, near Mayaguez.*

in the usual way for cane planting. Ridge terraces were staked out, opened with a hillside plow and then cleaned with ditching spades. Three different falls were used in laying out the furrows, namely, 1 percent, $1\frac{1}{2}$ percent and 2 percent.

Five furrows spaced $3\frac{1}{2}$ feet apart were made on a 1-percent grade, five furrows $3\frac{1}{2}$ feet apart on a $1\frac{1}{2}$ -percent grade and five furrows $3\frac{1}{2}$ feet apart on a 2-percent grade. This series of furrows was continued down the slope until the field was completed. Between every alternate five rows a ridge terrace was made with the same grades as the furrows. A spacing of 37 feet between each ridge terrace was allowed to intercept the run-off from the area between each five furrows. A terrace outlet channel designed to take a maximum intensity of 8 inches per hour was constructed and properly sodded with Bermuda grass. The furrows and ridge terraces acted as individual ditches to carry the rain that fell on the field into the main outlet channel.² This type of construction eliminates the customary practice of making small ditches down the hill and breaking the furrows when heavy rains occur; thus it prevents soil and fertilizer loss and at the same time conserves moisture.

The field was planted on April 24, 1938. One cane seed to the stool, of the P. O. J. 2878 variety, was planted in the furrows in a single row instead of the usual double row planting. This method reduced the seed cost by 50 percent. No fertilizer was applied until the cane was 2 months old; then 10 hundred-weight per acre was used. The cane closed very quickly and only 4 cleanings were necessary as compared to the 6 or 7 required by the Puerto Rican system.

At the age of 5 months, the cane reached a height of 9 feet. On September 15, 1938, the grades of each furrow and ridge terrace were checked. Where the slope of the land was 33 percent only a small group of the furrows with the 2-percent grade had changed to approximately $1\frac{3}{4}$ percent. Part of this change was

due to silting and part to earth falling in from the furrow ridge. It should be added that the day after the cane was planted, a rain of 9 inches in 5 hours was recorded. No damage was done to the furrows and the ridge terraces drained perfectly with only a slight silting.

In November 1938 when it was 8 months old approximately 60 percent of the cane arrowed. On May 6, 1939, when the cane was 12 months old 0.4 cuerda (0.97 of an acre) was cut. The small plot from which the cutting was made was one of the poorest parts in the entire field. The cane was shipped to Central Fajardo and according to their records the plot produced 14.61 tons of cane with an analysis of: brix 21.5; purity 85.7; sucrose 53.84. The yield for this field was 36.52 tons per cuerda.

Immediately after the plot was harvested the trash was lined, one cultivation was given, and 200 pounds of fertilizer was applied. While it is too early to make definite statements regarding the advantage of this type of cultivation as compared with the usual planting methods the following advantages are listed as probable:

1. Less seed will be required to obtain a complete stand of plants,—this because of the retention of more moisture in the field and the prevention of soil and fertilizer loss.
2. Four weedings only were given to the field because the cane closed quickly. This compares with 6 or 7 weedings normally given in this region.
3. Although the poorest part of the field was cut, it produced 36.52 tons per cuerda (spring cane) as compared with an estimated 30.33 tons per cuerda produced on the adjoining slopes. It is reasonable to assume that had the entire field been harvested it would have produced about 40 tons per cuerda.
4. This method of planting aids considerably in preventing the falling or breaking down of cane and thus reduces damage due to rot.
5. The first ratoons (regrowth) are a favorable indication of the advantage of this system. These ratoons closed with only two cultivations and in 2 months reached a height of 6 feet.
6. Contour cultivation conserved the moisture; the rainfall during these 2 months was 9.29 inches which, compared to the same 2 months of 1938, is less than half.

This preliminary experiment shows clearly the great need for a much more comprehensive knowledge among the sugar growers of soil conservation practices. Every effort is being made by the Service to aid them.

² Soil Conservation Service rainfall records show that in this area on April 25, 1938, 9 inches fell in 5 hours.

TRAILING INDIGO, A PROMISING LEGUMINOUS FORAGE PLANT

By ROBERT L. DAVIS and BERNARDO FIOL VILLALOBOS ¹

MANY leguminous plants are being introduced by the Soil Conservation Service Research Station at Mayaguez. Some of them have already been discarded as not adapted to our conditions while others are still under observation. Among the latter is trailing indigo (*Indigofera endecaphylla*) which spread more rapidly than any other legume in the preliminary tests made during the year 1937. It is considered promising as a forage and erosion-control plant for Puerto Rico. This article deals with a series of observations made on trailing indigo at the Soil Conservation Service Research Station at Mayaguez.

Trailing indigo (*Indigofera endecaphylla*) is a legume belonging to a large herbaceous genus, well distributed over all the tropics and common in rather dry climates. It is an annual or biennial trailing herb found throughout the tropics of the Old World. It is subject to root diseases in humid locations and is apt to wilt and suffer from inadequate formation of root nodules.²

Seeds imported from the island of Ceylon were planted on October 4, 1938, on Catalina clay lowland. In order to obtain a good germination, they were treated with a 50-percent solution of sulphuric acid for 25 minutes and then soaked in water for 24 hours. They were planted at a distance of 18 inches between rows and about 5 inches between spots, using 6 to 8 seeds per spot. This was at the rate of about 5 pounds per acre. Two weedings were given during the first 90 days when the plants were small. Growth closed in during the fourth month and required no further attention. This indicates that trailing indigo will compete with the common weeds of the island, with the possible exception of malojillo (*Panicum purpurascens*) which outgrew it, and green cohitre (*Commelina elegans*) which survived competition underneath the mat of trailing indigo stems.

In August 1939, 10 months after planting, samples were gathered to determine the probable erosion-control value of trailing indigo. The results of observations are given in table 1.

As noted in the table this plant, in 10 months' time, will produce over 600 leaflets per square foot of ground

TABLE 1.—Counts and measurements per square foot of ground surface made on trailing indigo 10 months after planting (Aug. 8, 1939)*

Samples	Leaves	Area per leaflet **	Total stem length	Stem diameter	Maximum possible interception area		
					Leaves	Stems	Stems and leaves
	Number	Square inches	Feet	Inches	Square feet	Square feet	Square feet
No. 1.....	767	.....	300	0.103	9.20	2.57	11.77
No. 2.....	651	.....	306	0.090	7.81	2.29	10.10
No. 3.....	625	.....	258	0.080	7.50	1.72	9.22
No. 4.....	625	.....	228	0.080	7.50	1.68	9.18
Average....	667	0.212	274	0.088	8.00	2.06	10.06

* Data gathered by William López, principal agronomy aide of the Puerto Rico Reconstruction Administration.

** Average found from 100 leaflets measured. An average of 9 leaflets per leaf was found by counts of 100 leaves. Stem diameters are averages for 10 stems.

surface. This furnished a protective cover of about 8 square feet for each square foot of land planted. Hence, most of the raindrops are caught by the foliage and do not strike the ground directly. Furthermore, there were nearly 300 feet of stems per square foot of ground; most of them occupied approximately a horizontal position and thus gave additional protection. The apparent protective value of trailing indigo at this time compared well with that of Bermuda grass growing in the same field. The average length of internode was 2.5 inches, and there were 33 primary roots per node and 1,284 nodes per square foot. Since about one-third of the internodes or 428 per square foot were rooted, it is calculated that there were over 14,000 primary roots protecting the soil on each square foot of the field. This is over 10 times as many as were found in Bermuda grass sod in an adjoining field of the same soil and constitutes another indication of its probable value for erosion control on steep slopes.

According to Burkill, trailing indigo has been used as green manure in Ceylon, where it was effective in preventing erosion on tea estates and in conserving or even increasing soil fertility. Its use under tea plants indicates that it will withstand considerable shade.

Trailing indigo has long been used as a forage plant in the East Indies. As reported by Burkill, the leaves and stalks when tender and succulent are readily eaten by cattle, although the plant will not stand heavy grazing. The oxen at Mayaguez ate it readily. With its succulent foliage and great number of small bright-green leaflets, trailing indigo resembles alfalfa. In

¹ Agronomist of the Soil Conservation Service, Puerto Rico Division, and agronomy aid of the Puerto Rico Reconstruction Administration.

² Burkill, I. H. A Dictionary of the Economic Products of the Malay Peninsula, 1935.

forage production it apparently compares well with molasses grass (*Melinis minutiflora*); on a $\frac{1}{20}$ -acre plot it produced 8 tons of green forage per acre when 8 months old. Average length of stem was found to be 7 feet and 8 inches which was the approximate spread during a 10-months' period. It grew on top of the native grasses and formed a dense mat with numerous succulent stems. Three months of this period were very dry and the surrounding grasses suffered severely, while the trailing indigo remained green and healthy. These observations indicate that it would do well in contour pasture furrows.

As a stock feed it seems to have a high value as shown by the following chemical analysis made by Dr. D. H. Cook of the School of Tropical Medicine of the University of Puerto Rico:

TABLE 2.—Analysis of trailing indigo (*Indigofera endecaphylla*) made June 8, 1939

	Calculated on a wet basis	Calculated on a dry basis
	Percent	Percent
Moisture.....	78.50	
Crude protein.....	4.21	19.56
Ether extract.....	0.93	4.33
Crude fiber.....	5.86	27.24
N-free extract.....	10.29	39.04
Ash.....	0.21	9.83
Calcium.....	0.297	1.38
Phosphorus.....	0.0439	0.0204
Total solids.....	21.50	

A test has also been made, on Mucara clay, to determine the cost and effectiveness of propagating by seed and cuttings. In this test the use of five seeds, one cutting and two cuttings per spot, were compared in triplicate on $\frac{1}{20}$ -acre plots. All spot plantings were made at intervals of 3 feet on contour ridges spaced 2 feet apart. The average percent of stand, as determined from counts made 9 and 18 days after planting, is given in the following table:

TABLE 3.—Average percent of stands obtained by sexual and asexual propagation of trailing indigo

Method of propagation	Stands on dates given	
	First count (Oct. 4, 1939)	Second count (Oct. 13, 1939) *
	Percent	Percent
By seeds.....	58.2	58.2
One cutting.....	66.8	51.3
Two cuttings.....	85.1	77.9

* The first period, from Sept. 26 to Oct. 4, had an average daily rainfall of 0.526 inch and the second period, October 4 to 13, had an average daily rainfall of 0.082 inch. The counts are averages of three plots in each case.

Better initial stands were secured from both the one cutting and two cuttings per spot than from seed. It should be noted, however, that the stand from seed was not reduced at the end of the 18-day period, while

in the case of cuttings there was about a 10-percent mortality. This mortality was attributed to dry weather. The planting cost per acre, although only \$2.10 in the case of seeds, averaged \$9.04 for cuttings.

An average of 302 cuttings was obtained from a square yard at a cost of about 97 cents, which indicates that this kind of planting material is inexpensive and that the high costs involve mainly the hand labor used in planting it.

A Few Conclusions

Trailing indigo seems adapted to dry conditions at Mayaguez and will probably withstand the long winter's drought.

It probably will compete successfully with all common weeds of the island with the exception of malojillo and possibly green cohitre.

As an erosion control plant it seems very promising because of its numerous roots along both nodes and internodes, and because of its dense mat of stems and leaves which seem to compare well with that of Bermuda grass as a protective cover.

AN ATTEMPT AT WATER SPREADING

(Continued from p. 26)

The area has been fenced and all stock has been permanently excluded.

The project has been worked cooperatively with the owner, who has supplied cement, barbed wire and posts for the fencing, and Guinea grass seed, and has lent oxen and plows for the work. The method of treatment and also the structures have been kept as simple as possible so that they represent merely a labor outlay. This has been done with a purpose, as the project is a demonstration and may be imitated by other farmers at very little cost. The added moisture should not only increase the density of the grass cover but should tend to keep the pasture green over a more extended period. Stock farmers think that, while 3 acres of pasture is required for each cow, enough feed can be cut from 1 acre of cultivated pasture to feed 3 cows. More cultivated pastures do not exist in this region merely because there is no assurance of sufficient moisture to make pasture cultivation worth while. This water-spreading project which, after all, is also a flood irrigation project, may point the way toward overcoming the shortage of moisture and the conversion of more native grass pastures into cultivated pastures. The demonstration is being very closely watched by neighboring stock farmers and we have had many requests for Merker grass seed for source-bed planting.

SOME PUERTO RICAN SOILS AND THEIR USE CAPABILITIES

By JORGE J. LANDRON ¹

IT IS a well-known fact that there is great variability of rock formation, climate, and vegetation in Puerto Rico. The soils, which are the product of time and weathering interaction between these factors, are no exception to the rule. According to preliminary reports and information, about 374 types and phases under 120 soil series have been mapped. These figures show extreme variability of soil conditions for an island only about 4,000 square miles in area.

A soil survey of Puerto Rico has been made by the Bureau of Chemistry and Soils (now the soil survey division of the Bureau of Plant Industry) in cooperation with the Rio Piedras Insular Experiment Station. Although the final map and report have not yet been published, we have been well supplied with preliminary reports and maps and the information set forth in the 1938 Yearbook of Agriculture. In carrying on our conservation erosion surveys we have correlated our field work with the soil survey findings on the island.

On the island there are two broad divisions of soils. Those on the north side of the divide, where rainfall is high in most places, usually are referred to as north coast soils. Here the soils are leached, and the majority are Lateritic (Pedalfers) while on the southern part where rainfall is low the soils are less acid or alkaline. On the southern coast, foothills, and inner plains, we find the Pedocalic soils, Chernozem, Chestnut, Prairie, Brown, and others of the great soil groups of the world in scattered areas. Altogether there are about 21 great soil groups represented in Puerto Rico; probably there is no State in the Union having such a broad range.

On the western coast there is a serpentine formation extending east of Mayaguez, about 20 miles in length and averaging 2 miles wide. This serpentine gives rise to two series, the Nipe and Rosario. The Nipe is the only true Laterite soil on the island and has been correlated with the Nipe soil of Cuba. The Rosario is a skeletal Lateritic soil formed on the steeper sides of the serpentine ridge. Apparently, the Nipe Laterite was formed on a level to a rolling position on top of the formation, under an average annual rainfall of 82 inches and a vegetation of tropical trees and brush. Because of its high content of iron, in the form of limonite and averaging about 82 percent, it is

considered a nonagricultural soil. The top 4 inches consist of dark reddish-brown friable porous clay with high quantities of organic matter. From the first 4 inches of topsoil downward, there is very little change in color and in chemical and physical characteristics.

The bedrock is often 20 feet deep and the depth very variable, as the serpentine has weathered in pockets. A typical iron hardpan or crust is present at variable depths from the surface depending on the amount of erosion that has taken place. In some instances the crust is exposed on the surface, while in others it may be 16 to 20 inches from the surface and about 4 to 8 inches deep. Many concretions are present scattered throughout the profile. This limonite consists of concretions varying from a few inches to 2 or 3 feet in diameter. Underneath this crust, which in some places is exposed at the surface, is a uniform mass of highly colloidal, friable clay varying in depths from 2 to 15 or 20 feet, and resting abruptly on the serpentine rock.

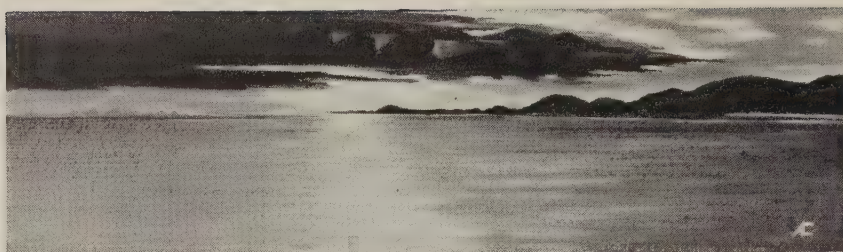
It is often thought that soils in Puerto Rico are well protected by a heavy tropical vegetation. Because of the density of population practically all the land is in farm land and in the interior mountainous areas of the island very steep and naturally shallow soils are cultivated to subsistence crops. There is a large percentage of idle land, which gives the impression of being completely abandoned; but this type of land is merely "resting" and will be idle for a period of years until the native vegetation builds it up and restores part of its lost productivity. This land will then be put back into cultivation under a year-round growing basis. In such circumstances, created by the steep slopes (60 and 70 percent), high rainfall and type of cultivation, there is no doubt as to the severity of erosion that takes place. The cycle is repeated over and over, but each time its productive period becomes shorter until finally the land must be entirely abandoned.

The main soil series found on the areas that have been worked are: Mucara, Catalina, Cialitos, Descalabrado, Cayagua, Panduras, Juncos, Jacana, and Coamo. Many others have been mapped, but those mentioned are the most important in extent, erosion, and moisture control requirements.

Mucara is an upland, skeletal soil found on steep to very steep slopes. The normal soil has about 4 inches

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of brown to grayish-brown topsoil underlain by a yellowish-brown silty subsoil with many angular fragments of rock present. It rests on



volcanic tuffs and ashes found at depths of 6 to 26 inches. This soil is used mostly for tobacco and minor crops, namely, sweet potatoes, pigeon peas, cowpeas, and beans. With a year-round growing season, it is not an uncommon practice to raise three different crops on a field in 1 year, and never less than two crops. On slopes of 40 to 60 percent, under intensive plowing and cultivation, it is not long before the subsoil is plowed up and mixed with the topsoil.

The Descalabrado series can be considered as a Mucara soil that has been developed under lower rainfall conditions from a similar kind of parent material except that in some instances it is partly calcareous due to the presence of limestone streaks running through it. Jacana is a soil associated with the Descalabrado and found in the foothills. It has a darker, deeper, and heavier topsoil over a yellowish-brown silty clay. Its topography is smoother and the soil itself may be 3 feet in depth to the tuffaceous parent material. Juncos corresponds to the Jacana, but is found in association with the Mucara series where rainfall is higher.

The Panduras and Cayagua series are derived from quartz diorite granite. Panduras is a skeletal soil having a dark gray-brown coarsely granular surface and lighter colored subsoil with no B horizon development and many large quartz diorite granite boulders present. It very seldom is over 6 inches deep down to rotten granite.

The Cayagua series consists of about 4 to 6 inches of light gray-brown gritty sandy clay loam over 10 to 16 inches of yellowish, more compact sandy clay resting on rotten granite. This soil was classified with the gray-brown Podzolic group.

Catalina is one of the most extensive soil series of the island, and has attracted great attention during recent studies made by J. A. Bonnett of the Agricultural Experiment Station at Rio Piedras, especially with regard to the laterization process as related to chemical, physical, and mineralogical studies of its profile.

The Catalina series is derived from andesitic tuff under a tropical climate with an average rainfall of about 80 inches. The position is variable. Sometimes it is found on top of the ridges on a relatively rolling

topography (5 to 15-percent slopes) while again it is found on slopes of 60 to 100 percent. This gives rise to the great variability of depths of

the profile to the decomposed bedrock. It ranges from about 4 to 40 feet in depth.

The Cialitos series can be described briefly as a shallower soil, resembling Catalina and derived from shales or finer grained andesitic tuffs. The B horizon is heavier and more compact; fine mottling occurs at about 18 inches, and the total depth to rotten parent material very seldom exceeds 48 inches.

The Coamo series consists of deep alluvial terraces under the Chernozem or Chestnut groups. It has been formed under low rainfall conditions, about 30 to 40 inches of annual precipitation, and by outwashed materials from Descalabrado and Jacana soils. The top 10 inches consists of dark-brown to almost black compact clay which cracks badly during dry weather. The B horizon, 10 to 26 inches, consists of a layer of yellowish-brown clay, grading into stratified sands and gravel. The B horizon is strongly alkaline to calcareous, and lime concretionary accumulations are found in the lower deeper strata. Rainfall distribution is very poor in this region, but where water is available Coamo soils produce very good crops.

In making conservation survey maps, we are facing the problem that most of the work has been done on very steep slopes, above 40 percent. The predominant soils on these slopes belong to the Mucara and Descalabrado soils, which are very shallow (skeletal). These soils may vary from 4 inches to about 30 inches in depth to bedrock. As the topsoil is only 4 to 6 inches deep on noneroded soils, as soon as the land is plowed the subsoil is brought up and exposed to erosion. It is obvious that a soil 8 inches deep may have as much as 3 inches of the original topsoil mixed with 5 inches of subsoil; but as the noneroded soil originally had only 4 or 5 inches of surface soil, its degree of erosion varies between classes 2 and 3 as used on the Puerto Rico survey (class 2 erosion on this survey, less than 25 percent of the original topsoil removed; class 3, 25 to 75 percent removed). On the other hand, a soil that has lost the same amount of topsoil but which has 10 or 12 inches of subsoil would fall in the same erosion class but would be more suitable for cropping. Recognition of these differences is very significant in determining use capabilities of land.

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Compiled by **ETTA G. ROGERS**, Publications Unit



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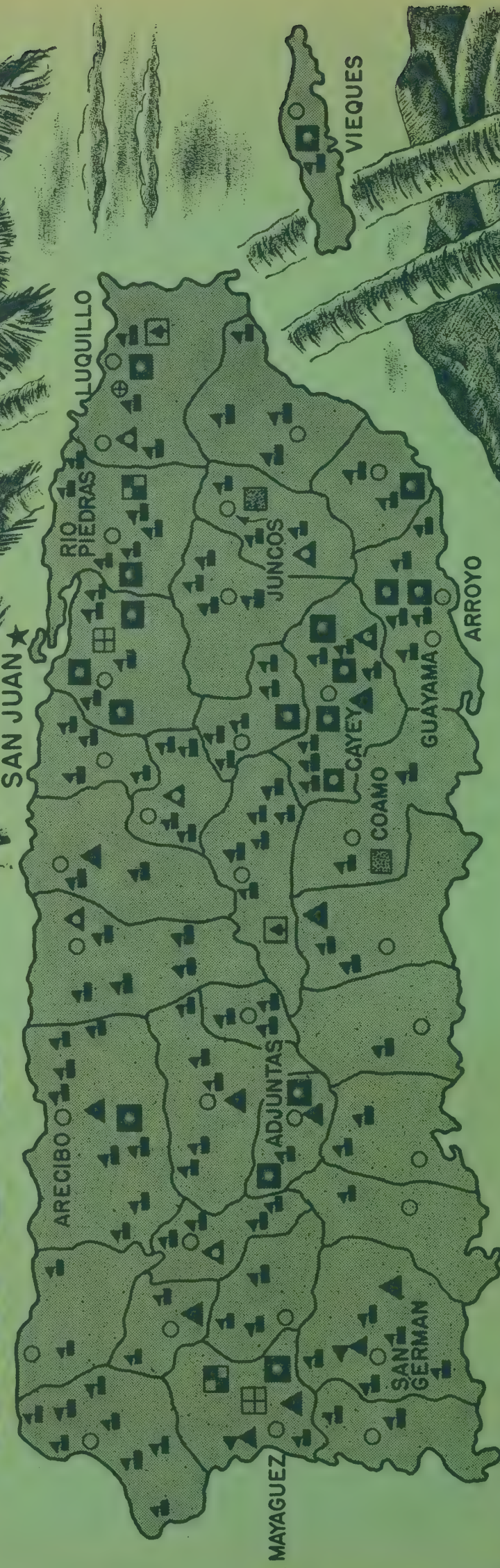
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SOIL CONSERVATION ACTIVITIES PUERTO RICO



- | | |
|---|---|
| 116 Vocational agricultural schools | 2 Colleges (land grant and polytechnic institute) |
| 32 Agricultural extension agents headquarters | 2 Forestry service demonstration |
| 18 P.R.A. resettlement farms | 2 Private farm areas |
| 9 Extension demonstration farms | 2 Soil conservation experiment stations |
| 6 Extension agents in soil conservation | 1 Sugar cane demonstration (central) |
| 2 Experiment stations (federal and insular) | ★ Headquarters Soil Conservation Service |
| — Boundary of agricultural extension agents territory | |

C O O P E R A T I N G A G E N C I E S

AUGUST 1940



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UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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WELLINGTON BRINK
EDITOR

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A QUANTITATIVE STUDY OF THE SUBTERRANEAN MEMBERS OF SOYBEAN

By HOWARD J. DITTMER¹

A METHOD to facilitate the study of a plant's adaptability for erosion control was proposed by the writer three years ago.² Soil samples 3 inches in diameter and 6 inches deep were taken with a cutting tube, and counts and measurements were made of the included plant parts. These samples were found sufficient for making predictions as to a plant's soil-binding efficiency. The tool used for sampling was an iron pipe with an inside diameter of 3 inches and a tapered cutting edge to facilitate entrance into soil when driven with a heavy maul. Samples were taken of widely grown agricultural plants and counts and measurements were made of their subterranean members. Complete quantitative data of Kentucky bluegrass, oats, and winter rye also have been published.³

The soybean (*Soja max* Illini) was selected for this study because it is of great economic importance and is widely used in crop rotation even on fields subject to erosion. Soil samples similar to those previously mentioned were taken from a field under cultivation that had then been planted for its third successive year in soybeans. The yield was between 35 and 40 bushels per acre. The soil was carefully washed from the root members, and quantitative data were obtained through counts and measurements of the roots and root hairs. Table 1 gives the statistical data for the subterranean members of soybeans.

The taproot system of soybean is very poorly adapted for erosion control. Most of the branching is from 1 to 2 inches below the surface, giving the topsoil very little protection. The taproot has an average diameter

of 2.5 mm. and this accounts for considerable volume but comparatively little exposed surface area for contact with the soil. The secondary roots, although not very numerous, expose more surface area than any other root division. Tertiary roots (those arising from the secondary members) were the most numerous and had the greatest total length. However, because of their small diameter, their surface area was smaller than that of the roots of the preceding category. Although they divide as far as the quaternary division, the roots of this category are exceedingly small; they average only 4 mm. in length and in all expose only 4.6 square inches of surface area.

Table 1.—Data showing totals for soybean roots and root hairs in a soil sample 3 inches in diameter and 6 inches deep (42 cubic inches)

ROOTS					
Subterranean members	Total number of roots	Average root length	Total length of roots	Average diameter of roots	Total root surface
	Number	Millimeters	Feet	Microns	Square inches
Main.....	4	120	1.5	2,500	5.6
Secondary.....	211	45	31.1	650	30.0
Tertiary.....	1,899	8	49.5	306	22.6
Quaternary.....	1,012	4	13.3	233	4.6
Total.....	3,126		95.4		62.8

ROOT HAIRS						
Subterranean members	Number of root hairs per millimeter of root length	Total number of root hairs	Average length of root hairs	Total length of root hairs	Average diameter of root hairs	Total root hair surface
	Number	Number	Microns	Feet	Microns	Square inches
Main.....	0	0	0	0	0	0
Secondary.....	606	2,271,819	110	819	17	20.6
Tertiary.....	210	3,190,320	90	941	14	19.5
Quaternary.....	170	688,160	90	203	14	3.2
Total.....		6,150,299		1,963		43.3

¹ Instructor of Botany, Chicago Teachers College, Chicago, Ill.

² Howard J. Dittmer: A Quantitative Study of the Roots and Root Hairs of a Winter Rye Plant (*Secale Cereale*). American Journal of Botany, July 1937.

³ Howard J. Dittmer: A Quantitative Study of the Subterranean Members of Three Field Grasses. American Journal of Botany, November 1938.

Table 2.—Data showing comparative totals for all roots and root hairs in a soil sample 3 inches in diameter and 6 inches deep (42 cubic inches)

	Total number of roots	Total length of roots	Total root surface	Total number of root hairs	Total length of root hairs	Total root hair surface	Volume occupied by roots and root hairs	
	Number	Feet	Square inches	Number	Feet	Square inches	Cubic millimeters	Percent
Soybean.....	3, 126	95. 4	62. 8	6, 149, 299	1, 963	43. 3	6, 286. 1	0. 91
Oats.....	4, 713	150. 1	49. 0	6, 370, 751	26, 386 (4.9 miles)	534. 4 (3.7 sq. ft.)	3, 785. 8	. 55
Winter rye.....	6, 410	209. 6	77. 9	12, 536, 381	55, 108 (10 miles)	1, 190. 0 (8.2 sq. ft.)	5, 869. 0	. 85
Kentucky bluegrass.....	84, 544	1, 260. 0	332. 0	51, 647, 770	169, 528 (32 miles)	2, 447. 9 (16.9 sq. ft.)	18, 085. 0	2. 80

Root hairs were found over the surfaces of all roots except those of the primary division, where secondary thickening had completely removed the epidermis. Hairs were most abundant on roots of the tertiary category, chiefly because of the greater length of the roots in this division. Root hairs of soybeans were different in appearance from those of the grasses previously studied. They were very short (90 to 110 microns) and of comparatively large diameter (14 to 17 microns). Because of their size, root hairs of soybeans are poorly adapted for binding soil. Their total surface area is small and they do not extend far from the roots. On the other hand, root hairs of grasses are long and small in diameter, cover a larger area and expose considerable surface. It is this large surface area exposed by root-hair members that is so important in binding soil.

Table 2 presents in summary the quantitative data of the subterranean members of the roots and root hairs of three grasses in comparison with soybean. Bluegrass has over 50 times the surface area exposed by soybean. Winter rye has nearly 30 times and oat has 12 times the subterranean surface of soybean. Kentucky bluegrass, because of its habit of growth, covers the soil much more efficiently than any of the other plants. Its fibrous root system grows evenly and forms a compact mat. Its prodigious number of roots and root hairs present a large surface area potentially in contact with the soil.

Very significant in soil studies is the volume occupied by subterranean members. The last column of table 2 shows the volume expressed in percent. Soybean has fewer root members and exposes very little surface, but occupies more volume in the soil than either oats or rye and about one-third the volume occupied by bluegrass although the latter has over 50 times the surface area of soybean.

A dicotyledonous plant increases its conductive capacity by increasing its diameter in secondary thickening. Monocotyledonous plants, lacking cambium, increase their conductive capacity by increasing the

number of main roots arising directly from the stem. This fibrous-type root system is typical of grasses and binds the surface soil tightly. A taproot system, as found in soybean and many other dicotyledonous plants, penetrates the soil deeply but does not bind the surface soil.

All soil in direct contact with roots and root hairs may be considered bound. Particles of soil closely held between the subterranean members may also be considered free from erosion. Consequently, monocotyledonous plants with their small but numerous roots and root hairs and enormous surface are far more efficient than most dicotyledonous plants.

The role of these four plants in binding soil has been known by soil conservationists for some time. This study shows, however, why Kentucky bluegrass is superior to the other plants and why soybean is a very poor plant to be grown on fields subject to erosion. It shows also that the soil-binding potentialities of a plant may be determined in a very short time by making quantitative studies of its roots and root hairs.

According to a 3-years farm-management study by Purdue University, pasture produced livestock feed very much more cheaply than any harvest crop was produced; these calculations were made after costs of labor, seed, lime, fertilizer, rent and taxes were deducted. In fact, pasture produced about 40 percent of the annual feed at 15 percent of the cost. This indicates that every effort should be made to lengthen the grazing season without overgrazing any particular pasture. Fertilizing permanent pastures and making proper use of winter small grain, crop residues, aftermath, and other supplemental pastures make it possible to obtain a very large part of the feed from pastures.—A. T. Semple.

TO BE PUBLISHED SOON

An article by B. W. Allred, "Crested Wheatgrass in Competition with the Native Grassland Dominants of the Northern Great Plains."

STRAWBERRY CLOVER IN THE NORTHERN GREAT PLAINS

By WAYNE W. AUSTIN¹

STRAWBERRY clover (*Trifolium fragiferum*) is one of the more recent introductions in the Great Plains, and undoubtedly will play an important role in the reclamation of low wet areas where the water table is near the surface. It does well on wet soils which have a relatively high alkali content; however, it makes its maximum growth and produces higher yields of forage on wet soils having little or no alkali.

This new legume is a perennial, low-growing, creeping, pasture-type plant that spreads by sending out trailing stems which root at every joint. It strongly resembles white Dutch clover when not in bloom, although the flowers and heads bear no resemblance to white Dutch. The flowers are rather large and round, and vary in color from pink to white. The mature seed ball, or head, resembles a miniature balloon made up of many compartments. Each of these compartments contains a seed which breaks from the head when ripe and may be distributed by livestock, wind or water. The seed is smaller than that of red clover, but larger than white clover seed, and may vary in color from a reddish brown to a mottled yellow and brown. The seed heads of strawberry clover usually contain a high percentage of hard seed; for satisfactory stands from raw seed, it should be scarified before planting.

Because of its ability to withstand flooding for short periods, strawberry clover is especially adapted to low, wet areas. Its alkali tolerance makes it a valuable plant for use in pastures that are too salty for the more common grasses and legumes. This plant has the ability to establish itself in wet meadows having thick stands of saltgrass, alkali-grass, and alkali weed. In pastures where there is a heavy concentration of salt, strawberry clover will take over the low, wet areas, leaving the saltgrasses and alkali weed on the drier high spots. It has been known to survive salt concentrations up to 4 percent.

Carl A. Larson,² working in Washington and Oregon with strawberry clover, found that, in pastures with high water table and with salt concentrations near the surface, the root systems of the plants were restricted and close to the surface. On the better



A 2-year-old stand of strawberry clover, showing two rows of clover planted 3 feet apart in the Lander, Wyo., Soil Conservation Service nursery. Within the 2 years the ground between the original rows has become completely occupied.

drained soils having a low salt concentration, strawberry clover plants were found to have a rather extensive root system, penetrating to a depth of 31 inches. He also found that flooding helps remove salt concentrations on the surface, and thus makes growing conditions more favorable for this clover.

Strawberry clover is not a dry-land plant; it will not grow on high, dry ground. White clover and strawberry clover have very similar water requirements. Strawberry clover is able to withstand longer periods of flooding and is more alkali-resistant than white clover.

Strawberry clover is not a native of this country. Dr. E. A. Hollowell³ states, "Strawberry clover is a native of the eastern Mediterranean and southern Asia Minor countries; however, it has been widely and inadvertently spread by man. It has been observed on every continent of the world; and wherever it is grown, the value of the pasture herbage has increased." It appears likely that strawberry clover

¹ Assistant chief, regional nursery division, Northern Great Plains Region, Soil Conservation Service, Lincoln, Nebr.

² Carl A. Larson: The Adaptability of Strawberry Clover to Saline Soils. Bull. No. 353. State College of Washington, Agricultural Experiment Station, Pullman, Wash.

³ E. A. Hollowell: Strawberry Clover. U. S. Department of Agriculture Leaflet No. 176. 1939.

found its way into this country by way of Australia, probably mixed with other plant seeds. Escaped plants were found in the eastern part of the United States over 50 years ago. Later, small areas of it were found on irrigation projects in several of the western States.

The Soil Conservation Service has had this clover under observation at the Lander, Wyo., nursery for several years. In 2 years' time, because of its stoloniferous growth habits, rows planted 36 inches apart closed in completely. Although strawberry clover seed is somewhat difficult to harvest, it is capable of producing a high yield of excellent quality seed. A 1-year-old stand of strawberry clover, planted in 36-inch rows for seed production, in the Soil Conservation Service nursery at Mandan, N. Dak., produced almost 200 pounds of clean seed per acre under irrigation. When this stand gets into full production it should yield between 400 and 500 pounds of clean seed per acre.

Strawberry clover is highly palatable and very nutritious. All classes of livestock and poultry relish it and usually graze it so closely that seed production is limited. Larson found that strawberry clover grown on alkali-free land had a higher nitrogen and calcium content, but a lower phosphorous content than plants at the same stage of maturity grown on alkali-impregnated soils. Strawberry clover will stand up surprisingly well even when grazed continuously from early spring to late fall. Too close grazing in the late fall however, may result in a high percentage of winter killing which will affect the carrying capacity the following year.

This new legume does best when planted in a grass mixture. A pure stand of this clover may cause bloat; but there is little danger of bloat when it is used in a mixed grass pasture.

Several fields of strawberry clover are scattered throughout the western part of Nebraska and the eastern part of Wyoming. One sizable pasture containing strawberry clover is located in Morrill County, Nebr., northwest of Northport, on the Bart Moore farm operated by Henry Nagel. The Bridgeport C. C. C. camp technicians became very much interested in this pasture and arrangements were made with the owner and the operator to use C. C. C. boys to collect some of the seed on a share basis; 110 pounds of clean seed were obtained and at the same time the camp agronomists collected some very interesting historical data concerning this field.

Mr. Nagel said that when he moved on to the farm in 1935, this pasture of 46 acres was covered with salt-

grass and other wet meadow plants. The field was seepy, and during certain times of the year it became very boggy. On May 15, 1935 he turned 44 head of steers on the pasture; after 90 days of grazing it was necessary to supply supplementary feed, and at the end of 105 days the steers had to be moved because there was no feed left. In 1936, the pasture produced only enough for 44 head of steers for 60 days.

In the spring of 1937, Mr. Nagel secured a pound of scarified strawberry clover seed and planted it during May in small plots scattered over the pasture. Each plot was protected from grazing by means of cattle guards consisting of two posts with slats nailed across them. Several different methods of planting were tried. On one set of plots the sod was removed with a shovel and the ground was spaded and packed; the seed was surface-planted, raked in, and then packed again. On another set of plots, the sod was removed but the ground was not disturbed and the seed was surface-planted, raked in, and packed. The third method consisted of giving the area to be seeded a thorough raking without disturbing the sod, then surface-planting the seed, raking it in, and packing it well. In the fall when the cattle guards were removed, Mr. Nagel found clover plants on all the plots, but in every case very much better stands of clover were found on plots where the sod had not been disturbed but only worked up with a garden rake. When the cattle guards were removed from the plots the cattle were still in the pasture. Numerous seed balls were present, filled with ripe seed, and these were eaten by the cattle.

In the spring of 1938, two more pounds of seed were planted and protected as in the previous year. The old plots were not covered, however, and the cattle were allowed to graze them at will. Then during the late summer of 1938 Mr. Nagel made an important discovery: he noticed that small clumps of clover plants could be found widely scattered over the pasture and, in almost every instance, these clumps of clover plants were on or adjacent to old droppings. The cattle had eaten the ripe seed balls the fall before and as the seed passed through the digestive tract of the animals the hard seed coats were softened and made permeable to water. When this excreted seed came in contact with the moist, well-manured earth an excellent stand of clover seedlings was soon started.

By the fall of 1939 the clover had spread over the entire pasture. It is still somewhat patchy, but this condition will not last long because the clover spreads by means of runners which enlarge each patch until the ground is rather thoroughly covered. By the end

of 1942, this field should be one solid mat of clover and grass.

Mr. Nagel has been keeping accurate figures on the number of livestock this pasture is carrying and the amount of supplementary feed he has used each year along with it. The following table shows the benefit he has derived to date through the addition of strawberry clover to this 46-acre pasture:

Year	Number of animal units	Total number of days pastured	Animal days without supplements	Animal days with supplements	Total number of animal days	Total number of animal months
1935.....	44	90	3,960	660	4,620	154
1936.....	44	60	2,640	None	2,640	88
1937 *.....	45	70	3,150	None	3,150	105
1938 *.....	78	120	9,360	* *	9,360	312
1939.....	78	107	8,346	2,574	10,920	364

* Strawberry clover seeded in small plots in May.

* * Some feed left.

On May 3, 1939, 66 head of steers, 7 horses, 5 milk cows, and 3 calves were turned on this pasture. On August 17, the steers were given about one-fourth full fattening rations. On September 20, all livestock were removed from the pasture although considerable feed was left. The Soil Conservation Service C. C. C. camp then came in and collected 110 pounds of clean seed—and a considerable amount of seed remained after they had finished.

The steers, after being removed from the pasture,

Land subject to erosion and planted to cotton, corn, and wheat loses an average of approximately 25 tons of soil per acre each year. If we consider the original topsoil as being worth \$200 an acre, or 20 cents a ton, an average of \$5 should be charged annually against each acre of cultivated cropland for the soil lost. If the nitrogen, phosphorus, and potassium in the soil loss were charged at 5 cents a pound, then the value of this soil loss would amount to about \$35.—A. T. Semple.

Good perennial grass pastures, properly stocked, lose only a small fraction of the amount of soil that is washed from land in cultivated crops. Good pastures lose soil more slowly than new soil is formed; thus, they are truly soil building.

Research studies made by the Bureau of Dairy Industry have shown that while the total amount of milk is reduced by feeding principally roughage and pasture, the unit cost is sufficiently less to make the lower production more profitable to the farmer.

were put on full feed. They were sold on December 4, 1939, after having made a gain of 501 pounds per steer, or an average gain of 2½ pounds per day per steer while they were in Mr. Nagel's possession. Although no scales were available on the farm to check the exact weights, it was believed that at least half the gain was made while on pasture. If a 250-pound gain is assumed from the pasture, the profits per acre undoubtedly were greater than for any other field on the farm.

These gains speak well for Mr. Nagel's ability as a livestock feeder. He is very modest about his ability, but he is eloquent in his praise of strawberry clover. He reports that it is not "washy" as so many legume feeds are, and that his livestock has not suffered from bloat although no precautions were taken to avoid it.

It appears that strawberry clover is unsurpassed for wet boggy pastures. It also seems to offer considerable promise for irrigated pasture mixtures. It would be well to watch this plant closely and even try some small patches in a low-lying pasture in order to find out what it will do. Certainly this clover shows promise of filling a long-felt need for a wet pasture legume in the irrigated section of the Great Plains and, by utilizing these wet areas for pasturage, a better system of farming is possible for the entire farm.

Safety Record Commended

The following is from a letter from the Office of the Director of the Civilian Conservation Corps, dated May 31, 1940:

"Receipt is acknowledged of your letter * * * covering personal injuries sustained by C. C. C. camp enrollees while under the supervision of the Soil Conservation Service during the month of April 1940.

"We wish to congratulate your Service on the new all-time low in frequency rate of lost-time accidents per 10,000 man-days worked. This is an excellent record and your field representatives should be highly commended for their efforts in making this record possible.

"We especially wish to congratulate Regions 6 and 7 for having operated 25 and 17 camps, respectively, without a lost-time accident during the month.

"* * * We want to thank you and your entire personnel for your splendid cooperation in our Safety Program and hope that your future reports will be equally as gratifying."

STRIP CROPPING IN THE LAND OF THE THOROUGHBREDS

By EWING JONES¹



Five inches of rain in a little over 24 hours did little damage to the soil of a tobacco field planted on the contour.

WHEN the Virginians and the Carolinians poured through Cumberland Gap into Daniel Boone's "dark and bloody ground," the more fortunate ignored the tumbling hills and forests of the mountain country, and went on to the tall canebrakes and buffalo ranges. That country now is Bourbon County—home of the thoroughbreds. Today, it is almost impossible to buy a farm in the rich bluegrass-limestone section, known as the inner-bluegrass, because the land is handed down from generation to generation.

A curious paradox makes Bourbon County unique agriculturally: Less than 12 percent of the land is cultivated, yet that acreage yields 45 percent of the cash income. One crop represents 40 percent of the cash income, yet only 4 percent of the county's acreage is in that one crop. The one crop is burley tobacco. Kentucky leads the Nation in burley tobacco production, and Bourbon County leads Kentucky. Its claim to the best burley in the State is unchallenged. As Phil R. Watlington, county agricultural agent, expresses it, "Bourbon County is shaped like a diamond, and its tobacco glistens like a diamond on the market." The county produces an average of more than 1,000 pounds of white burley per acre each year.

Good quality burley depends on three chief factors. First of all is good quality soil. The soil in the inner-bluegrass is of limestone origin. Generally speaking it

has been protected through the years by almost continuous bluegrass cover that has anchored the soil, given it a high content of humus and organic matter and, through absorption, has maintained a fairly uniform water level. Much depends on the climate, factor number two, and on commonsense management, the third factor. The predominant factor, however, is the soil. Burley tobacco is a rich-land crop.

The Soil Conservation Service began work in the inner-bluegrass in 1935, through the operations of a C. C. C. camp at Carlisle, when there was no strip farming whatever in the entire area. Today, 5 years later, contour strip cropping has become the most popular single soil-saving practice in the balanced agricultural planning. Of course, there is much more to the program than strip cropping, but the contour bands of bluegrass and burley stand out above the other individual practices, chiefly because of the excellent sod.

The good sod is most important. Two years ago the county experienced a 5-inch rain in a little over 24 hours, and the creeks roared with flash floods. On the farm of Reynolds Letton, one tobacco patch that had been planted in the usual manner, following the boundary fence, suffered severe sheet erosion and was even scoured to bedrock in spots. An adjoining field owned by Letton but farmed by another tenant, *on the contour*, lost little of the soil so precious to these sons of the pioneers. Just across the creek in a field of corn planted in rotation contour strips, the soil movement was slight. In some instances the soil washed out of the cultivated strips and nearly halfway across the sod strips—but no farther. The good sod checked the flow of water, made it drop its cargo of topsoil, filtered it out, spread out the flow of the raindrops.

Near Millersburg the camp technicians signed an agreement with J. W. Parker in the fall of 1937 and immediately laid out contour strips on all the sloping land to be cropped the next year. When the cloud-burst came slight soil movement was noted; but none of the colluvial fans extended across the bluegrass control strips. It was a different story on the adjoining farm belonging to Mr. Parker's sister. A field of similar soil and slope was planted to tobacco in straight rows. After the rain it was found that the eroded soil had covered a fence and piled up nearly a foot

(Continued on p. 51)

¹ Regional division of information, Ohio Valley Region, Soil Conservation Service, Dayton, Ohio.

RECLAMATION AND PROTECTION OF DANISH HEATH AREAS

By MELVILLE H. COHEE

THE Danish Heath Society was founded in 1866. The chief objective was to promote reclamation, improvement, and profitable cultivation of waste lands in Jutland of Denmark. At that time about one-fifth of Denmark was uncultivated, and of this expanse the Jutland Heath accounted for approximately 2,800 square miles, including the Danish part of Schleswig.

In ancient times and far into the Middle Ages many parts of the Jutland Heath were under cultivation. During the immediate centuries after the Waldemars (twelfth and thirteenth centuries) there were wars and epidemics which scattered the population. As a result of the wars large wooded areas were burned, and the land was laid bare to the strong western and northwestern winds which came from the sea. As the communities were hampered in their existence and the old balance of land use became more and more altered these areas in Jutland, left unattended, were gradually possessed by the undesirable heather, and thus it was that, in time, the heath became almost entirely uninhabited.

As early as 1723 a Royal Decree by Frederik IV, and later similar measures in 1751 by Frederik V, sought to encourage reclamation of the heath lands by exempting operators from military service and from taxes. But these measures proved inadequate, probably because the pressure for reclamation was not sufficient to start actual work. Another attempt in 1760 was almost a complete failure; German colonists were brought in to do the heavy tasks, but as insufficient preparations had been made for facilitating their work their success in mastering the heath areas was meager. Lack of roads and inaccessibility to marl were the two main handicaps to reclamation prior to 1866.

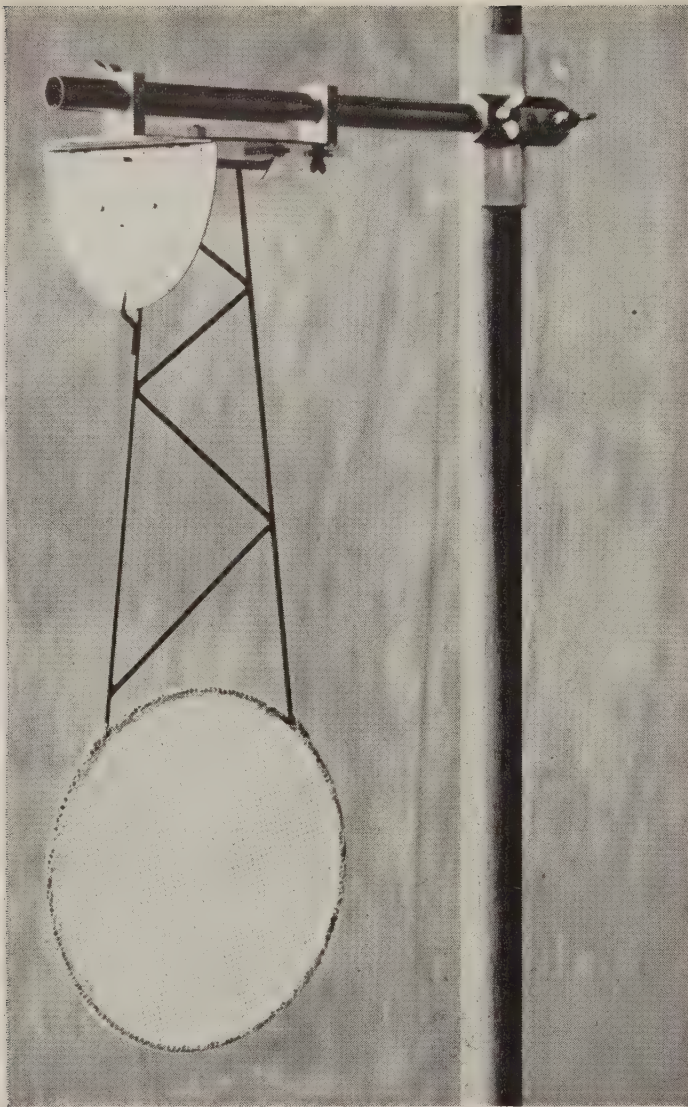
Col. E. M. Dalgas, founder of the Danish Heath Society, realized that a well-coordinated program must be formulated and carried forward if the heath was to be reclaimed. "Single track" measures had been proved worthless by those who carefully analyzed the conditions. Colonel Dalgas knew that certain fundamentals must be attended to simultaneously; roads must be provided, drainage and irrigation works must

be constructed, marl must be made available, and along with reclamation of the land for cultivation and meadows large plantations and shelter hedges must be established to protect the soil from the severe climate. With such a sound program this leader soon commanded the confidence of all who were genuinely interested in the national welfare of the country, and support was given him from all sides.

The work of the Heath Society has moved forward steadfastly from its time of origin. Both private and State subsidy has been given for its work and today the once large waste area is reduced by more than 50 percent. The reclamation and improvement of such an appreciable part of this small country is remarkable—the total area of Denmark is 16,569 square miles. Such success has been possible only through the carefully made plans of the far-sighted leaders, backed by the united will of the people of this old country to find room for expansion and agricultural self-sufficiency in their own land. In addition to reclamation of the heath lands proper, much has been accomplished in the drainage and cultivation of moors and the reclamation of lakes scattered over the country.

The Danish Heath Society is a private organization and, like other societies of Denmark, does not find its origin or rules for operation in a State law. The membership is composed of all who contribute yearly not less than 5 kroner (approximately \$1) to the society, or not less than 100 kroner for a life membership. The affairs of the society are attended to by a Board of Directors, consisting of 44 members elected by the total of 9,000 members (at present), and a Managing Committee consisting of 9 members. Officials of the Managing Committee are: The chairman of the Board of Directors; 3 members chosen by the Board of Directors from their 44 members; 3 members from the staff of the State Department of Agriculture; 1 member from the Federation of Danish Agricultural Societies, and 1 member from the Federation of Danish Smallholders' Societies. The society in the last few years has maintained an expanded works program and an annual budget of, roughly, 2 million kroner. The proportion of the budget coming from society members is very small. Work of the society carries on regardless of source of funds, and State subsidy (the primary source of funds) has not been given with any

NOTE.—The author is principal soil conservationist, Soil Conservation Service, Washington, D. C. He made studies in Denmark in October and November 1939 while in Central Europe in connection with a fellowship granted by an American scientific foundation.



1. A swinging disc anemometer.

demands for a change in the organization; State interests are safeguarded by the civil servant representatives on the Managing Committee.

The field of work of the Danish Heath Society is today far reaching. It includes construction of irrigation canals and drainage works, road building, establishment of forest plantations, planting of hedges, research for and opening of marl beds, building of marl railway routes, construction of embankments and dikes, and cooperation in technical instructions concerning the operation of heath lands. Much of the work of the society involves the furnishing of technical personnel for project planning. In many instances specific State laws provide regulations for carrying out the work—letting bids for work to private contractors, or arranging for labor and materials to be furnished by the State to a given degree, etc. And the society becomes the planning agency, and later the administrative agency, until a specific project is completed. Following completion of many of the different types of projects, the society technicians



2. A double-row hedge, 11 to 12 feet high, near Viborg (Jutland), Denmark; *Picea glauca*, *Picea canadensis*, and *Picea alba*.

must inspect the work regularly to assure proper maintenance.

It is impractical in this brief space to attempt to cover in detail all the types and extent of work done by the Heath Society. It should be of interest, however, to the American conservation technician and the farmer to have a brief review of one important and new phase of the operations, namely, the wind velocity measurement project in progress near Viborg. During the last 2 years, the society, in cooperation with Prof. Chr. Nøkkentved of the Royal Technical College of Copenhagen, had made field measurements of the effectiveness of different types of hedges¹ in reducing wind velocity. Professor Nøkkentved's years of experience with research in wind pressures and velocities around buildings and ships provide him with an excellent background for such investigations.²

Since the early work of Colonel Dalgas, the Heath Society technicians have recognized the necessity of breaking the effects of the strong west and northwest winds that sweep over Jutland and cause severe wind erosion on the unprotected lighter soils. Even though plantations and hedgerows were established during the 70 years of the society's existence, no well-designed examinations were carried out to determine the effectiveness of hedges in this capacity. Consequently it is only through years of trial and error that the farmers have established patterns mostly to their own liking, and these vary considerably from farm to farm. Different species of trees are used; the density and height of hedges vary; the spacing of hedges generally follows no well-planned pattern; and, despite the prevalence of hundreds of miles of hedgerows, there is still severe damage by wind erosion. It is not

¹ The hedges or hedgerows referred to in this article are of the field-border wind-break type planted in rows. Usually one, two, or three rows are used and they are close together.

² Wind Pressure on Buildings, Irminger and Nøkkentved, Ingeniørvidenskabelige Skrifter A Nr. 23, København, 1930. Wind Pressure on Buildings, Irminger and Nøkkentved, Ingeniørvidenskabelige Skrifter A Nr. 42, København, 1936.

uncommon in certain areas that a farmer may need to reseed his grain after a "blow-out."

In this study a swinging disc anemometer, shown in photograph No. 1, was used in the field tests.³ It consists of a 20-centimeter ring, covered with porous material and swinging at the end of an arm, the angle of which is a measure of the wind velocity. Careful laboratory tests were made in a wind channel, and a monometer was used to establish the curve for converting angle of arm in degrees to velocity in meters per second.

At each field test station (location) two swinging disc anemometers are attached to a vertical bar. One anemometer is 1.5 meters (4.92 feet) above the ground, and the second is swung just above ground level. Results from the anemometer just above ground level proved to be of little use, as it was found that slight changes in topography influenced them. One station is established at the end of the hedge if this is possible, or, at a distance the height of the hedge on the windward side. Here is recorded the wind velocity as it



3. A single-row *Crataegus oxyacantha* hedge, 13 to 14 feet high. It exerts a retarding influence on wind velocity for a distance of as much as 20 times its height.

reaches the hedge without the retarding effect of the hedge. Four other stations are established on the leeward side of the hedge. One is located at a distance from the hedge equal to 3 times the height of the hedge (3h); a second is placed at a distance of 10 times the height of the hedge (10h); a third is located farther away (15h); and a fourth is placed at a distance from the hedge of 20 times the height of the hedge (20h). The measurement of wind velocity, "free" wind, entirely separate from the windward or leeward side of the hedge, is also determined in the vicinity.

For a given test, a series of readings is made, at 3-second intervals, for a single station, and the data are averaged. For any one trial at one hedge, two rounds of the stations are made, and the final measure-

Table 1.—Effectiveness of hedge shown in photograph No. 2, measured at hedge and different distances on leeward side, in reducing wind velocity for a distance up to 20 times its height

["Free" wind velocity, 3.10 meters per second, or approximately 6 miles per hour]

Position of station	Wind velocity		Changes in wind velocity *	
	1.5 meters above ground	Ground level	1.5 meters above ground	Ground level
	Meters per second	Meters per second	Percent	Percent
h ** before hedge	2.40	1.20	77.5	38.7
3h leeward from hedge	.65	.30	21.0	9.7
10h leeward from hedge	1.70	1.40	55.0	45.2
15h leeward from hedge	2.80	2.00	90.4	64.5
20h leeward from hedge	3.05	2.00	98.4	64.5

* Percent change is calculated by comparing reduced wind velocity on leeward side of hedge with "free" wind velocity nearby

** h = height of hedge.

ment recorded for each station is an average of the two calculations.

It is found that hedges which are very compact, i. e., less porous, do not reduce wind velocities over large distances. Therefore, such a hedge as is shown in photograph No. 2 is most effective when in a system of enclosed fields where the hedges are only 50 to 60 meters (155 to 170 feet) apart. This is because the effectiveness of such a hedge is soon lost after the wind goes beyond it for a distance of more than 10 times the height of the hedge (table 1). Other dense hedges in Jutland, of *Pinus mugo*, *Pinus montana*, *Crataegus oxyacantha*, *Sorbus intermedia*, *Sorbus scandica*, and *Sorbus succia* have been tested as well as those similar to the one shown in photograph No. 2.⁴ In each instance where the hedge is very close or compact, the results are the same regardless of the species. Tests with the same compact hedges and for wind velocities of 5 to 10 meters per second (approximately 10 to 20 miles per hour) showed the same type of results—satisfactory effectiveness only

⁴ Ibid, footnote 2. Data from the study of 30 hedges bear out the conclusions cited herein.



4. A hedge of *Sorbus intermedia*, *Sorbus scandica*, and *Sorbus succica* that is too open in the lower story to allow effective wind velocity control. Too, some ill effects are suffered from the undertow wind current on the leeward side. A single-row hedge.

³ Hedeselskabets Trdsskrift, Ulgivet Af Det Danske Hedeselskab, Nr. 4, 59 Aarag., April 1938.

over an area of approximately 10 times the height of the hedge. It is the opinion of the Danish technicians that the effectiveness of the different types of hedges here discussed is of the same relative importance when wind velocities are greater.⁵

Those hedges which are not so compact may give less total reduction in wind velocity near the hedge on the leeward side, but they are effective over a greater distance. Such a hedge is shown in photograph No. 3. Following a reduction in velocity at station 3h on the leeward side of these hedges, the change in wind velocity is gradual—it accelerates again to the same force it had when it entered the hedge (table 2). Such hedges, if properly established and maintained, need not be located so close together in order to control the wind and reduce its damaging effects.

Table 2.—Effectiveness of hedge shown in photograph No. 3, measured at hedge and different distances on leeward side, in reducing wind velocity for a distance up to 20 times its height

[“Free” wind velocity 5.53 meters per second, approximately 12 miles per hour]

Position of station	Wind velocity		Changes in wind velocity *	
	1.5 meters above ground	Ground level	1.5 meters above ground	Ground level
	Meters per second	Meters per second	Percent	Percent
h * before hedge.....	4.20	2.80	75.9	50.6
3h leeward from hedge.....	2.10	1.60	38.0	28.9
10h leeward from hedge.....	2.20	1.20	39.8	21.7
15h leeward from hedge.....	3.25	2.50	58.8	45.2
20h leeward from hedge.....	3.55	2.60	64.2	47.0

* Percent change is calculated by comparing reduced wind velocity on leeward side of hedge with “free” wind velocity nearby.

** h=height of hedge.

In many hedges the lower branches are not protected from livestock and other damaging effects. Such hedgerows frequently develop a dense growth in the upper story but this alone does not add sufficient resistance to reduce the wind velocity to any appreciable extent. In fact, in Denmark it frequently occurs that serious damage is done on the leeward side of such a hedge by the whirlwind effect of the undertow wind current, while the total reduction of wind velocity is not great at any point. See photograph No. 4 and table 3.

From these early wind velocity measurements, and subsequent data from continued study, the Danish Heath Society technicians expect to enhance their knowledge regarding the types of hedges which can best be recommended. They already recognize that uniform density of the vertical section of the hedgerow, both coniferous and deciduous, is essential. They also believe that the width of hedgerow has little influence on the area of land that the hedge will protect—height and density of obstruction structure

(trunks, boughs, and leaves) are the important factors. They are now well able to explain the air current routes about hedges that are dense at the top and open below. With this information and a knowledge of species adaptable to the various soils and climatic conditions of Denmark, the technicians can plan their hedgerow program with more economic precision. In the past some hedgerows have been made wider than they should be, often to the extent of more than one or two rows of trees, in the assumption that the wider the hedge the greater the area of wind protection.

Further examinations are being made in Denmark regarding relation of one hedgerow to another in a series perpendicular to the prevailing winds, or in an arrangement to enclose fields. In many places soil collects in the hedgerows, and further examinations will be made to determine the effect of this condition on the benefits of hedges. Further studies will be made regarding the effects of hedges with and without foliage.

Too often the details of hedgerows are overlooked when we are speculating on the advantages of the trees for wind velocity reduction. The Danish work clearly indicates that, even in cases where great differences in the density of hedges are not outstanding to the more than casual observer, the differences in influence in wind velocity reductions are appreciable. Some hedges have little beneficial effects and others are invaluable. Perhaps it is possible that valuable information relating to hedgerows and wind velocity could be added to that already existing in the United States, if field examinations were made by a process similar to that used by the Danish Heath Society. There are, in some of our wind-erosion problem areas, both new and old hedges that could be used for such a study and detailed information would be valuable for future planning of hedges. And, not only might there be a saving in the cost of establishing hedgerows, but wind velocity reductions and subsequent benefits could be closely calculated in advance of maturity of the trees.

Table 3.—Effectiveness of hedge shown in photograph No. 4, measured at hedge and different distances on leeward side, in reducing wind velocity for a distance up to 20 times its height

[“Free” wind velocity 3.4 meters per second, approximately 7.4 miles per hour]

Position of station	Wind velocity		Changes in wind velocity *	
	1.5 meters above ground	Ground level	1.5 meters above ground	Ground level
	Meters per second	Meters per second	Percent	Percent
h ** before hedge.....	3.25	2.35	95.6	69.2
3h leeward from hedge.....	2.80	1.90	82.4	55.9
10h leeward from hedge.....	1.90	2.00	55.9	58.8
15h leeward from hedge.....	3.10	2.20	91.2	64.7
20h leeward from hedge.....				

* Percent change is calculated by comparing reduced wind velocity on leeward side of hedge with “free” wind velocity nearby. ** h=height of hedge.

⁵ See sources of information cited in footnotes 1 and 2.



Elymus mollis (American dune grass) clones being obtained for transplanting on barren areas such as the one at the extreme left. Each year the growth of grass is completely covered by new sand and the dune may attain eventually a height of 40 to 60 feet.

GRASS AND ASSOCIATED VEGETATION TO RECLAIM OREGON'S COASTAL SAND DUNES

By T. A. STEELE¹

IN the fall of 1935 the Soil Conservation Service, with the aid of a C. C. C. camp, started the exacting task of revegetating the barren, drifting sands of the Clatsop plains area on the western rim of Oregon just south of where the Columbia River discharges into the Pacific. In the October 1936 issue of SOIL CONSERVATION, E. M. Rowalt described the area with its destructive surging dunes, and the control program initiated by the Service.² The program was then but a year old, and the studies of native and introduced grasses for use in halting the eastward advances of the dunes had just begun. In this article, progress of the work during the past 3½ years is described and illustrated, with special reference to plants that have been found valuable for stabilization of dune areas in this coastal region. Control measures were found to involve basically an understanding of ecological principles and their correct application. A definite plant succession, following in proper sequence and involving highly specialized plants adapted to the particular edaphic and climatic environment, is now being used.

Control measure on any coastal sand dune area are fundamentally the same. First, intensive grazing and extensive trespassing by man must be eliminated. Fire also constitutes a hazard where woody species

are included within the climax cover. As the prevailing winds are landward and the source of sand is the beach, it is obvious that a fore or front dune will retain a large percentage of the sand near the source, thereby giving vegetation to the leeward a opportunity to recover.

To establish a fore dune two parallel rows of pickets, 4 inches by 4 feet, are driven into the sand 30 feet apart, immediately above the high tide line. The pickets collect and retain wind-driven sand particles. When sand reaches the tops of the pickets it is planted to sand-binding grasses—Holland grass (*Ammophila arenaria*) and sea lyme (*Elymus mollis*). The new dune may eventually build up to a height of 40 to 60 feet as a result of sand deposition and regrowth of the planted grasses. Rapidity of growth is in direct proportion to the annual growth of the grasses as shown in photograph No. 1.

The barren areas behind the fore dune likewise must be planted to sand-binding grasses (photograph No. 2). The grasses *Ammophila arenaria*; beach grass (*A. breviligulata*); and *Elymus mollis* are capable of withstanding sand blasting and sand inundation and are planted during the rainy season (November through March) 18 inches apart in rows which are also 18 inches apart. Rows extend crosswise to the prevailing winds. Within one or two years these grasses prevent any appreciable sand movement within the

¹ Area agronomist, Pacific Northwest Region, Soil Conservation Service, Klamath Falls, Oreg.

² E. M. Rowalt: Anchoring the Clatsop Dunes with Vegetation. SOIL CONSERVATION, Oct., 1936.



Sand encroaching on Sitka spruce reproduction. The shrubby growth is *Cytisus scoparius* (Scotch broom) and *Salix* sp.

treated area and make conditions favorable for the succeeding plant association.

The secondary plant community may include yellow sand verbena (*Abronia latifolia*); silky beach pea (*Lathyrus littoralis*); *Lupinus littoralis*; bur sage (*Franseria* sp.); *Carex macrocephala*; *Poa confinis*; seashore bluegrass (*Poa macrantha*); and dune bent (*Agrostis palens*). Establishment of these plants through seed is an arduous task, but preliminary seedings under favorable conditions appear promising. Reproduction through vegetative means has a higher percentage of survival than by seeding, though the latter practice is by far the more economical.

Complete establishment of this vegetal group will make conditions favorable for the tertiary plant association. Plants within this group include sod-forming grasses which ensure stable control unless man-made maladjustments interfere. This climax vegetative cover may become established by natural plant migration or seeding, and it includes red fescue (*Festuca rubra*); Canada bluegrass (*Poa compressa*); velvet grass (*Holcus lanatus*); Australian ryegrass (*Lolium italicum*); *Agrostis* sp.; *Carex* sp.; and moss, as well as numerous other plant genera.

An outstanding example of the beneficial effects afforded by leguminous plants is seen on the semisterile dune sand. Grasses which follow the sand-stilling

plants are very slow in becoming established when sown alone. The seedlings are slow growing and yellowish in color, compared with vigorous dark-green and rapid-growing seedlings when sown with a legume. This same compatability continues as the grasses grow older. A straight seeding of *Poa macrantha*, for instance, acts as a "bunch grass," but when growing with a legume it will form a dense, rank growth and a sodlike covering.

The Soil Conservation Service does not expect to transform this wasted, barren sand area within a period of 5 years to its native state with a growth of tall grasses and legumes. But through strict adherence to formulated and established control measures, the Clatsop plains should revert in time to a vegetative cover similar to that found by the Lewis and Clark expedition. To ensure this transformation, capable and alert county commissioners and directors are striving to bring this area under public ownership. Such action would eliminate land exploitation and prevent a possible reversion to destructive migratory dunes.

SCHEDULED FOR EARLY PUBLICATION

An article by Hugh G. Calkins and D. S. Hubbell, "A Range Conservation Demonstration in the Land of the Navajos."

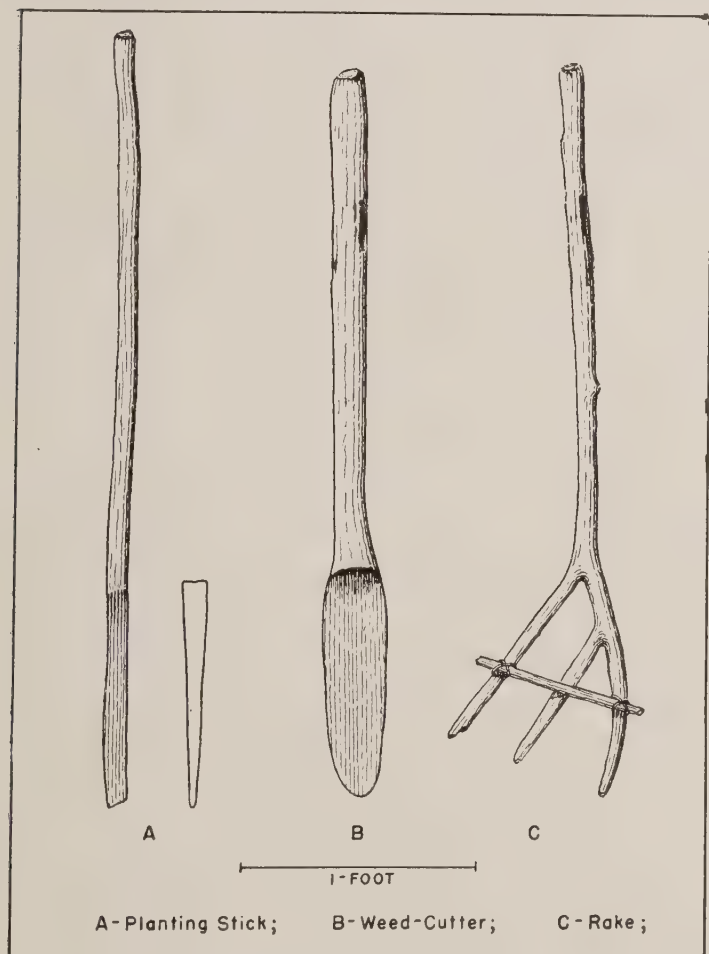
WATER CONSERVATION IN HOPI AGRICULTURE

By GUY R. STEWART and ERNEST A. NICHOLSON¹

IN recent years agricultural agencies have become greatly interested in methods of conserving water and stabilizing crop and pasture growth in the drier portions of the Great Plains and the agricultural valleys of the West. In view of this, it may be helpful to examine some of the methods used for centuries by primitive cultivators of the Hopi villages of northern Arizona in their efforts to make a living in the less favorable parts of a semidesert region.

Although the Hopi are commonly considered members of the Pueblo group of Indian tribes, it should be noted that seven of the eight villages speak a language related linguistically to the neighboring Shoshonean tribes such as the Utes. Apparently the original Hopi came in contact with the Pueblo Indians at an early period and completely absorbed Pueblo culture with its traditional observances used to propitiate the powers believed to govern the success of crops in this arid land. Whether it is due to the remoteness of their location or to the devotion the Hopi felt for their

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Hopi Agricultural Tools

acquired culture, they have been less affected than the Rio Grande Pueblos by contact either with Spanish explorers or with the influences of modern American life. The eighth village of the Hopi communities, Hano, located on First Mesa, belongs to the Tewa language group of the Rio Grande. These villagers took refuge at the head of the first mesa trail after the Pueblo revolt of 1680 and have continued to live there since that time.

The three southern branches of Black Mesa, on which the Hopi villages are situated, are usually spoken of as the first, second, and third mesas. No records have been obtained of the precipitation on the higher portions of the northern mesa; but the relatively heavy growth of juniper and piñon indicate that it is materially higher than the 16-year average of 12.7 inches (4) reported at Keams Canyon, some 13 miles from the first mesa villages of Walpi, Sichomovi and Hano. The elevation of the Hopi villages on the first mesa is about 6,000 feet, while the agricultural land on the southeast and southwest is some 300 feet or more lower. In contrast to this the higher land on Black Mesa rises to a height of 7,000 to 8,000 feet, which probably accounts in part for a greater precipitation on the uplands.

This higher rainfall in the upper mesa country provides two important sources of water which have been utilized by the Hopi to supply part of their crops. The major part of the upland run-off finds its way into a series of streams heading in Black Mesa and flowing out on to the plains to the southeast and west of the mesa village lands. In addition, part of the upper rainfall forms a seepage of underground water that moves along the mesa top. The upper strata capping the rocky formations consist of relatively permeable sandstone which dips southward. The sandstone is underlain by compact shales and movement of water into the lower strata is extremely slow. Thus it is that the underground seepage moves along the shale beds until the junction of the two formations is reached some 50 feet above the base of the cliffs where the Hopi villages are situated. This gives rise to a series of springs that form a valuable source of water for the village terrace gardens.

There is no indication that the rainfall on the croplands adjacent to the three mesas is heavier than that recorded at Keams Canyon. Even were this light rainfall well distributed throughout the growing season,

it would be insufficient for field crops such as corn and beans. The records, however, show enormous variation in annual precipitation which ranges from 5 inches in the driest years to 15 inches in the wettest. During most years there is a variable snowfall which has averaged about 27 inches, although it is doubtful that much of this moisture is effectively stored in the soil—this since the period from April through June, following the months when snow falls, is the driest and windiest of the year. Hence, evaporation is high during the period of planting and early crop growth. The most usual rains throughout the Southwest, especially during summer, are torrential thunderstorms of short duration and such as to produce rapid run-off.

These conditions point to the necessity for supplementing local rainfall by utilizing flood flow and underground seepage if crops are to be raised successfully. The methods developed by the Hopi in raising their staple crops of corn, beans, squash, melons, and peaches are based entirely on their own observations of local conditions and antedate any contact with white civilization. Success of the Hopi plantings depends upon the use of flood water run-off, as well as upon utilization of subsoil seepage areas and the development of terrace gardens on land adjacent to springs.

The greater part of the run-off from the higher mesa lands comes out in narrow streams which spread out over alluvial flats where the narrow canyons cutting the southern portion of the mesa give place to the flat valleys south of the Hopi villages. These lower lying valley lands may receive three or four floodings during June, July, and August. Since the flood flow is largely uncontrolled, water may at times stand to a depth of 5 to 6 inches until the excess is removed by evaporation and percolation into the subsoil. This shows one of the risks of flood water agriculture, for the smaller shoots of corn in valley fields may be drowned out by standing water. The fields along the sloping edges of the valley devoted to beans, melons, and squash depend upon run-off originating on the sides of the mesas.

In the lower flood fields an excess of water may wash out the corn where the current is excessively strong or may bury parts of the planted land under a heavy load of sediment. It appears probable, however, that risks such as these always have been a part of the systems of flood water agriculture practiced since early times. This is indicated by studies made by Mr. Nicholson, coauthor of this article, of the evidences of early agriculture found around many prehistoric sites. In addition, Dr. Ruth Underhill, (6), who has studied Indian irrigation among the Pima and other

tribes, has concluded that most primitive irrigation tended to be of the flood water type, rather than systematic regular applications.

The observations on Hopi flood-water methods recorded in the following are based especially on the field studies of Mr. Nicholson who has worked in this portion of Arizona for several years. For the convenience of interested readers, references are made to several accounts that treat more generally of primitive agriculture in the Southwest.

The land devoted to beans, squash, and melons is on the more sandy soils along the lower edges of the mesas where local run-off from the mesa sides supplements the variable rainfall. Fields for these crops are found also on the upper mesas, near the peach orchards, where seepage from underground drainage makes cropping possible. Most of these lighter lands have brush checks placed across the fields, against the prevailing winds, to reduce soil drifting and prevent the young seedlings from being cut off at the ground level.

In addition to the two sources of water that have been discussed, the larger springs at the base of the mesas furnish irrigation water for several series of terrace gardens in which sweet corn, chile peppers, onions, and other introduced vegetables are raised with great success.

In general, the corn land lies in the valley flood-water areas where more productive sandy loams and clay loams may be found. In places, however, hills of beans are sometimes planted between widely spaced hills of corn, on the lighter soils.

No tendency toward any system of crop rotation has been noted. This agrees with the observations of Beaglehole (1), who found that each family usually planted the major portion of inherited clan lands to the same crop each year. Forde (2) (3) has mapped the distribution of the various clan fields in the cultivated areas adjacent to First Mesa. The point of special interest in this connection is that each clan possessed land in several separated parts of the village fields. Hence, the chance of complete crop failure for any group of families from an excess of flood water, destructive wind, or a local concentration of cutworms was greatly reduced.

It was observed that prevailing winds from the southwest tended to blow away the lighter surface soil from the western side of many of the fields on the lighter soils. This caused a gradual shift of land use, as the cultivator often moved the border of his area some yards to the east each year. Finally a time would come, after a field had been cultivated for a period of years, when most of the lighter fractions of surface



Hopi terrace gardens supplied with water from Wipo Spring, First Mesa.

soil would be removed. Such a field then would be allowed to grow up to weeds and small brush. After a few years, sufficient silt and fine sand might be intercepted by this cover to permit that moisture be retained in the subsoil and the land be returned to cultivation. This process has gone on for many years. The line of soil blown away tends to form a definite dike extending out from the field border. The authors have noted this sign of early cultivation in a number of places in the Hopi and Zuni country where other evidences of human use have disappeared.

The preparation of the fields for planting is extremely simple. This work starts in late February and is completed at intervals during the spring period. Because of the danger from wind erosion when the soil is excessively pulverized, the plow has never been favored by the Hopi cultivator. Many men still cling to the use of the primitive wooden tools described by Hough (5) and shown in the accompanying sketch. Weeds and brush are removed either by the digging stick (A) or the wooden pusher hoe (B). Latterly some of the Hopi have adopted a heavy steel hoe for digging out weeds and cultivating the soil. Each family ordinarily prepares its own land by chopping off the weeds with the hoe and removing small brush by prying it out of the ground with the digging stick. Brush fences and windbreaks are rebuilt on the lighter soils where crops other than corn are to be raised. Any available type of brush, or tree branches, may be used for this purpose. The same windbreak material

will be allowed to stay in the ground even after it is defoliated, so long as the branches give some protection against wind action; but from time to time the low hedges will be reinforced when necessity arises. In the melon and bean fields the old roots will be removed as part of the land preparation, but in corn land the corn stumps of the previous year will be allowed to remain in the ground as a guide in order that the corn will not be placed in the same spot, and thus there is an alternation of planted area within the same fields.

Planting may start in late April or early May, depending on the season. On the first mesa, Beaglehole (1) reported that a series of nine ceremonial planting dates were fixed for the different crops. No such sequence has been noted on the second mesa. Here the villagers reported that each man observed the sun for himself and determined when the season was sufficiently advanced for the early crops. Watermelons are usually put in the ground first and followed by beans and early ceremonial sweet corn. The planting of the main corn crop does not start until the town crier announces that corn will be planted for the town chief 4 days later. The planting procedure is an interesting combination of mystical observance and sound agricultural practice based on long experience.

When the working party is assembled to plant for the town chief the men gather together for a ceremonial smoke and to breathe prayers for rain. Prayer sticks are placed before a field shrine and a handful of corn meal is sprinkled in the six major directions. After

the proper observances, the planters line up along the side of the field, so that each will plant some three to five paces apart. The rows are spaced in between the rows planted the previous year and the hills are staggered in each adjoining row so that no hill is opposite another nor are hills planted in the same spots as in the previous year.

Each planter clears away the surface soil with his foot and then digs a trough-like hole from 12 to 16 inches deep. The damp subsoil in the bottom of the hole is loosened and from 10 to 20 seeds are planted and covered to a depth of 8 to 10 inches. This deep planting enables the plant to obtain the maximum benefit from the stored soil moisture and develop a root system that will resist wind or excessive floodwater. The planting of a large number of seeds permits development of a leafy clump of stalks which protects the center stalks from damage by high winds. The excess seed also provides sufficient plants so that a stand is likely to be obtained even though mice or cutworms may invade the field. As soon as the corn sprouts, the soil about the hill is kept loose with a digging stick and weeds are removed with a weeding hoe. If the hill is in an exposed position it may be protected by a small brush fence or by circles of protecting stones. In many instances the hills are surrounded by low banks of earth to retain rain or floodwater.

The planted crops receive considerable attention during the early period of growth. Mice and rodents are trapped and cutworms are picked off by hand. Portions of the fields which fail to receive floodwater are leveled off or roughly trenched to promote a more even flow. Additional small windbreaks are constructed to protect squash, melons, or beans which are found to be exposed to the prevailing winds.

Weeds are cut with a hoe so as to conserve moisture during the time of most rapid development of the crop.

In the early period of Spanish settlement the Hopi acquired peach trees either from the missions or by trading with the Rio Grande Pueblos. Since that time the cultivation of this fruit has had an important place in the Hopi agricultural practice. Observation on the part of the Hopi orchardists showed that the seepage from springs and from underground water gave a supply of subsoil moisture adjacent to the mesas which was adequate for tree growth. Although there are a few budded trees on the mesas most of the new plantings are native peach seedlings. The fruit from these seedling trees is practically all freestone and though small, is excellent for drying. The peach trees are raised from seed, or cuttings, which replace the older trees as they pass their productive period. The young trees require careful attention and often need to be watered by hand until they are well established. The trees are planted by individuals in common village lands or clan fields and belong to the person who sets out and tends the tree.

Summary

Hopi agriculture constitutes an interesting combination of traditional ceremonial observance and sound conservation measures well adapted to semidesert conditions. Floodwater irrigation is the basis of crop production. The source of this floodwater is partly the run-off from the higher land of Black Mesa and partly local run-off which supplies small fields at the base of each mesa. Permanent springs supply water for a series of terrace gardens which produce chile peppers, onions, early corn and green vegetables.

(Continued on p. 51)



Brush checks, Second Mesa, recently put in to stabilize sandy land.

SOIL-CONSERVING PRACTICES SAVE FARM LABOR, POWER, AND EQUIPMENT USE

By RICHARD H. FLYNN ¹

WITH increased emphasis on the conservation of our agricultural resources, not only have new farm practices been established, but methods of carrying out the old practices have been changed. Contour farming has been recommended for the conservation of both soil and moisture. As this is a new practice in many parts of the Middle West, its permanency will depend on its efficiency in production, its immediate effects as an aid in the control of erosion, and how well it fits into the farm business.

In an attempt to measure the efficiency of contour farming as compared with the conventional or up-and-down-hill method, data were collected on a field basis in one Nebraska area ² for 1939. Records were taken on 139 fields of corn, barley, and oats on cooperating and noncooperating farms. Of these fields 79 were farmed on the contour, and 60 by the up-and-down-hill method.

Data were collected by survey for the operations performed up to the date of visit to the farms. Then forms were left with the operators so that they might keep records of the time and fuel used for the remainder of the operations in producing and harvesting the crop. The information collected on the fields includes the number of hours of man labor, horse work, and tractor time, the number of gallons of fuel consumed, and the acres covered for the various operations of disking, listing, harrowing, cultivating, drilling, and broadcasting. Data were also collected relative to the variety of seed, date of seeding, rate of seeding, and previous treatment and cropping history of the field. A record of each operator's machinery was obtained; this included such information as make, model, and size of tractor, and type and size of all other equipment used on the fields selected for study.

On the whole, the equipment used by the farmers who were cooperating in the soil conservation program in this district was similar to that of the operators who farmed by straight-row method. Within each group, however, there was some variation in the power rating of the tractors and in the capacity of some of the other

equipment. In order to set up comparable conditions, as far as the machinery was concerned, for comparing the results obtained on contour- and noncontour-farmed fields, the tractors were grouped according to the drawbar horsepower rating.³ Other pieces of equipment were grouped on the basis of working width, and teams were grouped according to the number of horses worked as a unit. The data from all of the fields studied in this district were tabulated according to the above-mentioned groupings.

Contour listing of corn was one of the more popular practices adopted by the cooperators in the soil-conservation program in the Plum-Beaver district. The usual tillage practices followed in the production of listed corn were disking, listing, harrowing, go-deviling, and two cultivations. Although a large proportion of the fields were farmed almost exclusively with tractors and tractor equipment, some fields were farmed either entirely with horse equipment or with a combination of tractor and horse equipment. The tables shown with this article indicate the average number of minutes of man labor and horse work, and gallons of fuel used per acre for performing each of the several operations in producing listed corn and in the seeding of small grain, such as oats and barley.

Table 1 shows the average time and fuel used in producing an acre of listed corn on fields farmed by the contour and by the straight-row or up-and-down-hill methods.

Table 1.—Average time and fuel used per acre on 24 contour- and 11 noncontour-listed corn fields

Operation	Time used per acre		Fuel used per acre	
	Contoured fields	Noncontoured fields	Contoured fields	Noncontoured fields
	Minutes	Minutes	Gallons	Gallons
Disking.....	20.3	19.8	0.47	0.52
Listing.....	27.5	30.7	.74	.85
Harrowing.....	9.2	10.1	.22	.24
Go-deviling.....	19.7	23.1	.39	.59
Cultivating (second).....	26.1	29.4	.57	.69
Cultivating (third).....	23.6	26.0	.54	.56
Total.....	126.4	139.1	2.93	3.45

While the difference was not great in the time and fuel used per acre by tractor operators for any indi-

¹ Junior clerk, economic research division, Northern Great Plains Region, Soil Conservation Service, Lincoln, Nebr. Credit is given to Earl L. Struwe, assistant agricultural economist, division of economic research, Soil Conservation Service, for assuming responsibility in collecting the data; and to L. F. Garey, professor of rural economics, College of Agriculture, University of Nebraska, for many helpful suggestions concerning the study.

² Plum-Beaver soil conservation district in Boone and Nance Counties, Nebr.

³ Summary of Results of the Nebraska Tractor Tests. Bulletins Nos. 265 (Jan. 1932), 304 (Jan. 1937), and 321 (Jan. 1939). Agricultural Experiment Station, College of Agriculture, Lincoln, Nebr.

vidual operation on contoured and noncontoured fields, the cumulative difference for all operations, as shown by the data in the table, indicates a saving for those farmers who followed contouring. This saving amounted to approximately 14 minutes of time and one-half gallon of tractor fuel per acre. Since the average field was approximately 30 acres in size, this would indicate a total saving of 7 hours of time, and about 15 gallons of tractor fuel for all the operations involved in seedbed preparation, planting, and cultivating each field farmed on the contour. By farming on the contour the average operator saves enough time per acre to cover an additional one-tenth of an acre or, on a field basis, an additional 3 acres. His fuel saving would permit him to cover even a larger area.

Table 2 indicates the average time used for the several operations performed by the farmers who used horses as a source of power in producing listed corn.

Table 2.—Average time used per acre on 23 contour- and 14 noncontour-listed corn fields

Operation	Man time per acre		Horse work per acre	
	Contoured fields	Noncontoured fields	Contoured fields	Noncontoured fields
	Minutes	Minutes	Minutes	Minutes
Disking.....	37.2	43.9	168.1	198.2
Listing.....	80.3	79.1	321.2	316.4
Harrowing.....	20.0	17.4	80.0	69.6
Go-deviling.....	40.7	38.8	162.8	155.2
Cultivating (second).....	64.7	63.3	165.6	162.0
Cultivating (third).....	51.4	71.8	159.0	192.0
Total.....	294.3	314.3	1,056.7	1,093.4

As in the case of the tractor farmers, a saving of time was observed for the operators who used horses as a source of power in farming on the contour. The saving amounted to approximately 20 minutes of man labor and 36 minutes of horse work per acre for the operators who contour-farmed, as compared with those who did not. Since the average field of corn, farmed by operators who used horses as a source of power, was approximately 23 acres, the total saving effected per field amounted to about 7 hours and 40 minutes of man labor and 13 hours and 48 minutes of horse work.

Another fact of interest is the more efficient use of man labor on the tractor-farmed fields. The same operations consumed approximately twice as much man labor when horses were used as a source of power as when tractors were used.

Barley and oats were seeded by drilling with a grain drill and by broadcasting with an endgate seeder on both contour- and noncontour-farmed fields. The

usual tillage practice followed when the grain was seeded with a drill was a double disking immediately preceding the drilling operation. When the grain was seeded broadcast with an endgate seeder, the more common practice was to scatter the seed and follow up with a single disking and a harrowing operation. The difference between contoured and noncontoured fields that were seeded by the broadcast method was that all operations were performed on the contour on the former fields.

Tables 3 and 4 indicate the average time and fuel used for each operation on fields farmed by both methods. Table 3 is based on the performance of the tractor and tractor-equipment operations, while table 4 shows corresponding results where horses were used by the farmer.

Table 3.—Average time and fuel used per acre in seedbed preparation and seeding of small grain on 11 contour- and 7 noncontour-drilled fields

Operation	Man labor per acre		Tractor fuel per acre	
	Contoured fields	Noncontoured fields	Contoured fields	Noncontoured fields
	Minutes	Minutes	Gallons	Gallons
Disking.....	20.3	19.8	0.47	0.52
Do.....	20.3	19.8	.47	.52
Drilling.....	23.0	29.5	.55	.61
Total.....	64.5	69.1	1.49	1.65

Table 4.—Average time used per acre in seedbed preparation and seeding of small grain, using horses on 3 contour- and 2 noncontour-drilled fields

Operation	Man labor per acre		Horse work per acre	
	Contoured	Noncontoured	Contoured	Noncontoured
	Minutes	Minutes	Minutes	Minutes
Disking.....	37.2	43.9	168.1	198.2
Do.....	37.2	43.9	168.1	198.2
Drilling.....	55.0	56.5	219.8	226.6
Total.....	129.4	144.3	556.0	623.0

These tables reveal that the operators who seeded their small grain on the contour used slightly less man labor, horse work, and tractor fuel than those who farmed up and down the hill. The use of horses, apparently, is not as popular as the use of tractors as a source of power for drilling small grain in the Plum-Beaver district.

Tables 5 and 6 show the average time and fuel used by the farmers who used endgate seeders for broadcasting the small grain seed.

Very little difference was found in the time and fuel used by the two groups of operators who seeded small

Table 5.—Average time and fuel used per acre in seeding small grain by broadcast method, using tractors and horses on 9 contour- and 5 noncontour-farmed fields

Operations	Man labor per acre		Horse work per acre		Fuel used per acre	
	Contoured	Noncontoured	Contoured	Noncontoured	Contoured	Noncontoured
	Minutes	Minutes	Minutes	Minutes	Gallons	Gallons
Broadcasting.....	13.8	13.2	27.6	26.4		
Disking.....	20.3	19.8			0.47	0.52
Harrowing.....	9.2	10.1			.22	.24
Total.....	43.3	43.1	27.6	26.4	.69	.76

Table 6.—Average time used per acre in seeding small grain by the broadcast method, using horses as the source of power on 13 contour- and 11 noncontour-farmed fields

Operations	Man labor per acre		Horse work per acre	
	Contoured	Noncontoured	Contoured	Noncontoured
	Minutes	Minutes	Minutes	Minutes
Broadcasting.....	13.8	13.2	27.6	26.4
Disking.....	37.2	43.9	168.1	198.2
Harrowing.....	20.0	17.4	80.0	69.6
Total.....	71.0	74.5	275.7	294.2

grain by broadcasting with an endgate seeder and followed up with a disking and a harrowing operation.

Although some variation was evident in the efficiency of performance among the individual operators, the data presented in the preceding tables indicate that less time and power were used for contour operations than for up-and-down-hill operations in the Plum-Beaver soil conservation district. The relative amounts of these savings may be ascertained by comparing the height of the bars in the accompanying chart. The performance on the up-and-down-hill farmed fields is represented as the standard, or 100 percent.

While the economies effected on contour-farmed fields in man labor, horse work, tractor and equipment use, and tractor fuel are not very large for the individual operator, they are of sufficient importance to merit the consideration of every farmer who is interested in increasing his efficiency and economy of operation. The implications of this reduction in time and power requirement are that farmers who adopt contouring as a part of their farming system are in a better position to (1) improve their timeliness of operations having seasonality, (2) increase their productivity, and (3) reduce their costs of production. However, due to severe drought conditions in this district during the 1939 crop season, evidence is lacking of the advantages gained from increased produc-

tivity due to timeliness of operation. Data obtained in this district in other years do indicate that crop yields were slightly higher on farms where the recommended practices were followed, and that the yields decreased with an increase in erosion. Since the cost of production up to harvest for the crops studied is not affected by the yield, it is safe to conclude the existence of an economic advantage in contour farming, even with the same yield, because of the saving in both labor and power when compared with up-and-down-hill farming. Any increase in yield resulting from contour farming would add still more to its economic advantage.

STRIP CROPPING

(Continued from p. 38)

deep on the highway at the lower edge of the field. It was impossible to estimate the amount of soil that was washed down the creek. Incidentally, the two tracts had been operated as one farm until 1937; hence, previous management methods would not account for the difference.

From a demonstrational standpoint, that one rain-storm did more good than a hundred speeches. The men at the Carlisle camp suddenly found themselves unable to cope with the flow of requests that came in for assistance in laying out strips. The energetic county agent did what he could, but he too fell behind in his work.

Thus Bourbon County farmers initiated their own soil-conservation program. Several of them began contour farming and strip cropping before agreements were signed. One noncooperator bought a field level like the one used by the camp and laid out contour strips on his five farms. Farmers in nearby Mason County, seeing the spread of strip cropping, hired their own engineers. Meanwhile, with every cropping season and every rain, the land of burley and the land of thoroughbreds is rapidly becoming the land of contour strip cropping.

HOPI WATER CONSERVATION

(Continued from p. 48)

Simple brush windbreaks have proved an important aid to the protection of crops of beans, melons and squash. The measures now employed in the Hopi country are suggestive of methods which probably prevailed among the Pueblo villages in the primitive agriculture of the Southwest.

(Editor's Note.—Literature citations were omitted for lack of space. Inquiries regarding source material should be directed to Dr. Stewart.)



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neill Faris

LAND ECONOMICS. By Richard T. Ely and George S. Wahrwein. New York, 1940.

This book is not in any sense "light reading," but it can and should be read for background by all of us who want to appreciate the actual objectives of the work of our Service. Many times we reach the point of wondering whether or not it is humanly possible to coordinate land policies and population trends for the safety of the land and the good of the race. If such coordination is to be attempted, then what are the factors that must be viewed from all angles in framing land policies for the good of the people? Some of us may go a little further in our thinking: If the land is for the people, then what are the people for? The new volume reviewed here should help greatly in thought processes which we hope will lead to solution of some of the problems regarding occupation and use of the world's land by two billion people.

In the first 20 pages some striking population trends and figures are introduced, and no doubt it was the authors' intention to show in the beginning that regulation of population numbers is not to be expected. Be that as it may, the book swings quickly over to the physical factors of land occupation and utilization. Climate as related to man is the first factor discussed; topography, soils, water in all its phases, land quality gradations, minerals and forests, and even subsurface and supersurface resources—all these are drawn together as land, or nature, in the attempt to give a clear picture of the economic problems of land use and productiveness at the hand of man.

Two chapters, "Land as Space" and "Land as Property" are quite new in compilation if not in concept. Room and situation, according to the authors' opinion, are land's only original and indestructible powers. They have gone far afield in gathering thought, idea, and opinion on the productiveness of land when labor and capital are applied to it, and in discussing means of determining the point where the "static law of diminishing returns" sets in. Their discussion of the expansibility of economic space gives rise to much thought and conjecture as to modern restlessness and the fate of the land, call it "space" or call it "property." In the chapter on property, the human attribute, ownership, is discussed from the standpoint of its influence on land utilization and land value. Here the writing is scholarly, unusually swift in thought continuity, and world-wide in scope, even though most of the concrete material is "United States." The idea of property is somehow unpleasant to think about, since except within his own mind man can never hope to own the world; yet there is no doubt that the many-faceted story of man's everlasting struggle for some part of the planet, down to the center of the sphere and up to the heavens, has become throughout the past 10 thousand years part and parcel and sometimes all of human existence. Those who think beyond economics may wonder which has, and may, suffer the more from man-made property "rights" extending even to the air—Earth or *Homo sapiens*. But property, ownership, possession, is another matter entirely when it comes to agriculture—making use, good or bad, of the land of the world for the good, or harm, of the human race.

In the discussion of "property" the authors of this book set up

their thesis by showing how, throughout the world, private property in land became valid, step by step, after "agriculture superseded grazing" until in the present era utilization of land by man demands a fine proportioning of social, commercial, and physical factors if land resources are to be used and at the same time conserved in a state of production for the future. Many extremely interesting and important trends and developments of past centuries are described: the "Dorf" or agricultural village as the unit of the feudal system; seigniorial tenure of Quebec resulting in "ribbon farms" impossible as economic units; alienation of public lands in the United States and Canada; Indian lands in the New World and a people who "had little or no concept of private property and were not aware of the rights they were surrendering." Social and political privileges associated with landed property during past centuries and in the present era, as discussed in this book, give rise to serious consideration of the dependence of state and federal governments upon "private property in land" in building land-utilization plans and programs.

In Chapter 5 the authors get down to the economics of land utilization in a world most of which "lives under a regime of private property in land." Production and land values are treated by the method of proportioning the many factors involved in making use of land and by applying the law of diminishing returns to determine increments from inputs. Rent, value of land, size of unit, management, institutional elements, competition, and costs of utilization are treated with much attention to detail and what might be called "subfactors." By proportioning all the factors the authors set the stage for their main theme—that "agricultural land can go longer without being repaired or replaced than other forms of agricultural capital" but that "inasmuch as farm land is subject to deterioration, the income of the operator must be sufficient to cover the cost of maintaining the productivity of the land." After this, the book becomes definitely a treatise on utilization of land for conservation of soils and all other natural land resources.

Agricultural land, as of prime importance in a world where human beings must live and produce food to live, is discussed first from the point of view of types of farm organization. In view of the two decades just past and the agricultural problems arising out of intensive industrialization of many areas of the United States, the authors' views on self-sufficing and peasant agriculture, and farming as an industry, are most illuminating in that they point out clearly wherein lie many of the most serious difficulties in soil-conservation and land-reclamation programs as related to future land-utilization policies. An excellent analysis of future demands and trends is to be found in the latter half of the chapter "Agricultural Land"; it is especially recommended for soil-conservation planners.

A specialized treatment of agricultural land tenure as related to soil conservation in the United States is presented in Chapter 7, and here is found considerable information regarding the work of the Soil Conservation Service. The soil conservation district is referred to as "the real impetus * * * to erosion control by collective action" in the United States. "Undoubtedly," state the authors, "these districts will, and in fact should, operate for some time before enacting land-use regulations, to permit ample time to gain experience with voluntary action."

For REFERENCE

Compiled by **ETTA G. ROGERS**, Publications Unit



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Alternate contour strips of bluegrass and tobacco are used by Kentucky farmers. The sod checks flow of water, thus minimizing soil loss from "inner-bluegrass" tobacco lands.

See the article by Ewing Jones in this issue.

SEPTEMBER 1940

FIELD OBSERVATIONS
BY H. H. BENNETT

AN ARTICLE ON CRESTED
WHEATGRASS

A DISCUSSION OF SIZE OF FARM
AND THE SOIL CONSERVATION
PROGRAM



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of \$1.00 per year, domestic; \$1.50 per year, foreign. Postage stamps will not be accepted in payment.



Erosion-control operations by government foresters on formerly cultivated land, after the land has been ruined by erosion, near Tzintzuntzan, Mexico.

TZINTZUNTZAN TO SINGAPORE

By H. H. BENNETT

Chief, Soil Conservation Service

AT TZINTZUNTZAN, archaeologists had been digging into the remains of the "city of kings" of the Tarascan Indians. I had to take the word of the diggers as to what was being found beneath the surface of the ground—what relics of this old, old race of agricultural Indians were being brought to light. But there was no difficulty in seeing what had taken place at the surface of the earth. Across the succession of centuries the Tarascans had used the lands out there on the southwestern edge of the great Mexican plateau, some 200 miles west of the City of Mexico.

The land scars to be seen in that locality are enough to jolt the most experienced student of land conditions. Here at Tzintzuntzan and all around the basin encircling Lake Patzcuaro, and far back into the mountains to the east, erosion has taken heavy toll of the land. The damage is measurable in terms of hundreds of thousands of acres. A very large portion of these thousands of damaged

acres—probably several million acres—has been so gullied or severely washed that the land is no longer useful for cultivated crops. Gullies—thousands of them—extend from the foot to the crest of many high hills; with other thousands reaching part way up, in a maze of trenches that have cut away the soil to depths of 10, 20, or 50 feet, or more—often, down to bedrock.

From a hilltop near the west side of Lake Patzcuaro, my companion and I estimated the area of erosion-destroyed land visible immediately around us at 12,000 acres. In a few places, tongues or island strips of soil—rather, of subsoil—are all that remain. In other places, pedestals, 4 to 10 feet high, showed that the bare, exposed rock all around once was covered by soil which had a subsoil depth at least as thick as the height of the pedestals.

At the present time, the Tarascans out of necessity—because of scarcity of productive land—are



Twenty-five years ago this Ottawa County tract was in farmland.

clearing mountain slopes so steep that severe erosion begins with the first year of cultivation.

Although they are an ancient race of agricultural people, strongly attached to the ways of tradition, they apparently have never looked upon the soil as a destructible resource. If they ever have realized that their productive land probably is the only thing that can save them from extinction, they have not changed their methods from the wedded ways of tradition; and they have done nothing to conserve the soil. They sometimes plant corn with a wooden stick, such as was used, according to the excavations of archaeologists, many centuries ago.

I do not think the Tarascans realize yet that they are coming very close to the limits of agriculture in the area that has been Tarascan for so many centuries. The yields of wheat seldom run above 3, 4, or 5 bushels per acre in most of the fields one sees in traveling about the country—although wheat is one of the principal crops. Erosion has affected directly both upland and footslopes; indirectly, the process has affected lowlands by deposition of poor subsoil material washed down from gullied hillsides.

After seeing all this land impoverishment and wreckage in the southwestern Mexican highlands,

one is rather rudely jerked up on seeing the excellent results in soil conservation obtained with simple measures used by other groups of Indians in other parts of the highlands of Mexico, as in the hills south of the City of Mexico. Here, one finds benches of deep soil accumulated behind substantial stone walls that were built across the slope, I was told, long before Cortez captured Mexico. In many parts of the State of Michiöcan—the center of the Tarascan civilization—gullies extend up and up the slopes in striated patterns of land destruction and agricultural exhaustion. In contrast, the country south of the City of Mexico reveals rock-supported terraces that ascend far up many slopes in bench-like patterns of conserved soil capable of supporting a continuous and rewarding agriculture.

I must confess that I can offer no explanation as to why the agricultural Indians in one part of Mexico have so completely left out of their culture all conception of the need for land protection, while the Indians in some other parts of the country, occupying much the same type of terrain, included in their culture a very fine conception of the need for preserving their most basic natural resource. This question was just as baffling to me as was the purpose behind the performance of the Ancients of Mexico who built such magnificent structures as the Pyramid to the Sun, at Teotihuacan.

Later, July 1940, at Singapore, 2,000 miles to the north, I was almost as much amazed as at Tzintzuntzan when I encountered a chimneytop after taking out a few spadefuls of sand on the crest of the sand dune at Saugatuck, on the west coast of the lower peninsula of Michigan. On the way to Singapore, which is, or was, about 70 miles north of the southwestern corner of the State, we were seldom out of sight of the effects of water erosion, or wind erosion, or both. In some vineyards, where the rows ran straight down the hill, we had picked up dead grapevines whose entire root system had been exposed by erosion—an effect representing the removal of more than a foot of soil and subsoil by continuous washing of the unprotected slopes. Not finding Singapore on the map, I was informed by my traveling companions that a satisfactory system for showing the location of towns like Singapore and Dewey, Mich., had not been worked out for the variety of highway maps we were using. The

trouble with putting Singapore on the map is due to the fact that the whole town has been blanketed over by a sand dune that moved eastward from the direction of Lake Michigan. The place once had a reputation as a lumber port of importance around the 1840's. But the removal of the forest from the sandy lands of the locality set in motion a scourge of wind erosion that eventually annihilated this lumber town on Saugatuck Bay.

Continuing north to Holland, carrying along a number of bricks and other remains exhumed at Singapore, we met two of the supervisors of the West Ottawa Soil Conservation District and promptly started out on a tour of the wind-eroded section of the district. I was told by the supervisors that 30,000 acres of land in that one district were bare and on the move as the result of wind erosion. It seems that in this part of Michigan, as well as many other parts, more sandy land has a tendency to blow rather violently after a few years of cultivation or overgrazing. The supervisors said that considerable land was affected by water erosion in the more rolling parts of the district, but they urged that we devote our time particularly to the wind-eroded section because of the wide distribution of the affected areas and the immediate necessity for getting them under control. They even spoke of the overwhelming magnitude of the

job of soil conservation immediately out in front of them. When I asked if they meant that they were approaching the point of giving up, they came back instantly with the assurance that they not only were not anywhere near the point of surrendering but very definitely felt that the work already accomplished was proof that erosion could and would be whipped through the use of practical control measures. "This district," one of the supervisors said, "began operations in the spring of 1939, but our farmers already have planted 700,000 trees and a great deal of beach grass, chiefly for controlling wind erosion in the sandy plains section."

They took me to the district nursery, where another million trees will be ready for planting very soon, and where an additional area is being prepared for enlarging the nursery. I think everyone who sees the erosion-control accomplishments of the C. C. C. camp working under the direction of the Soil Conservation Service, now aiding the district, is proud of what these boys are doing. In addition to what the farmers have planted, the C. C. C. boys have set out 900,000 trees, largely for stabilizing blow land.

We went over a completely successful sandy land stabilization job, where raw dune sand was creeping across farm land and roads in a very destructive manner. So loose and shifty was the blow sand,



Paling to halt drifting sand in the West Ottawa soil conservation district, constructed by C. C. C. enrollees. Small trees were planted in the spring of 1940 to establish permanent protection.



Even a thin mulch of wheat straw (about two tons per acre) is effective in protecting this Michigan orchard from erosion.

it seems entirely impractical for any easy control operations to be imposed; but precisely such operations had been carried out with perfect success by the erosion technicians and C. C. C. labor. Pine seedlings had been set out within squares planted to beach grass. The nine trees per square stood like brave little sentinels distributed over a compound. It was really amazing how such diminutive plants had in the course of a few months pretty effectively quelled the wrath of the wind which had been driving ahead loose sand having little more stability than the wind itself.

I left the supervisors of the West Ottawa Soil Conservation District with the feeling that not only would the 30,000 acres affected by wind erosion be put speedily under control, but that many other thousands of acres on the point of drifting, as well as the areas subject to water erosion, would be safeguarded.

Thus bolstered, I was able to withstand another shock at Grand Haven. Here, as we drove into the city, one of the erosion specialists opened a book dealing with the history of Ottawa County, which showed a picture of Dewey, across the river from Grand Haven, as it looked in 1886. It was a good picture, and Dewey was a clean-cut, prosperous-looking town. But when they took me to the river's edge and pointed across to a towering sand dune, saying "you are now looking at what once was the city of Dewey," my thoughts again ran back to Tzintzuntzan, where archaeologists had

to dig through the products of erosion in order to get at the handiwork of the ancient Tarascans.

I was told that it costs around \$28,000 annually to remove the sediment, largely wind-driven sand from the dune that had blotted out Dewey, from the harbor at Grand Haven in order to maintain adequate depths for navigation. I was told also that the sand was carried out into the lake on scows and dumped. Perhaps that is the only practicable way the dredged material can be disposed of, but it is somewhat discomforting to think that so much must be expended to remove eroded soil material in this circular sort of way, which will permit the material eventually to come back to the same place it was picked up.

Recalling that someone had spoken of dredging operations at Benton Harbor and Saugatuck, I asked for a rough estimate of the annual cost of keeping the harbors around the entire coast of Michigan adequately dredged. The reply was that it probably is \$100,000 at least for such operations—or more than was being spent by the Government in cooperation with the five soil conservation districts which had been established in the State at the time. (On the same day we went over the West Ottawa District, another soil conservation district—the sixth in the State—which was voted for an area in another part of Ottawa County.) From Grand Haven and the sandhill that had obliterated the town of Dewey from the face of the earth, we drove northward to Traverse City to



Sodded diversion terrace outlet established by the S. C. S. demonstration project in an old established orchard, Grand Traverse County, Mich.

inspect soil conservation work in that vicinity. On the way, we again were seldom out of sight of the effects of erosion, except while passing through occasional patches of wooded country. By the time Traverse City was reached, I was ready to ask, "How much erosion do you have in Michigan, anyway? I hadn't supposed there was anything like the area we saw today and yesterday."

I had heard a good deal about the cut-over sandy lands of the State, of rich muck soil and Kalamazoo celery, of Traverse cherries and prosperous farms, but certainly had not expected to see so much soil erosion. The answer to my question was: "Five million acres of land, mostly farm land, seriously affected by erosion, and approximately 600,000 acres of this pretty much ruined for any immediate practical crop use."

I should have pointed out that we were visiting the Grand Traverse County section not only to study erosion control and water conservation work but to attend and speak at the National Cherry Festival.

On the following day, we spent the forenoon and afternoon examining soil conservation work on farms cooperating in the demonstration projects centering about Traverse City. Farms were visited both along the mainland bordering the east arm of Grand Traverse Bay and on the Old Mission Peninsula that projects so beautifully into the bay.

On the tour there were leading farmers, county agents, erosion technicians, and representatives of various State and Federal agricultural agencies. We saw cherry, peach, and apple trees planted on the contour, and alternate inter-row cultivation with inter-row protective cover, usually a legume or grass. We saw hay- and straw-mulching, grassed waterways, contour strip cropping, field strip cropping, contour rotations, tree plantings, and other measures applied to fit the needs and adaptabilities of the various kinds of land.

Of special interest to me was a large farm where potatoes were grown in rotation with corn (or radishes), oats, and alfalfa. Here in a field, contour strip cropping was effectively controlling erosion. We were informed that previous to the installation of this conservation practice in 1940, erosion sometimes would cut deep washes across the entire moderately sloping area, some of which were difficult to cross with farm machinery. We were told also that 30 years of farm records showed that this eroding field had produced an average of about 30 bushels of wheat for the years it was used for wheat, as against an average of 45 bushels of wheat on a less sloping, adjacent tract of the same original type of soil, which had not suffered very much from erosion. The yields of wheat in the two fields were practically the same in the beginning, but recently

(Continued on p. 67)

BUILDING WITH *LIVE* MATERIAL



Kudzu



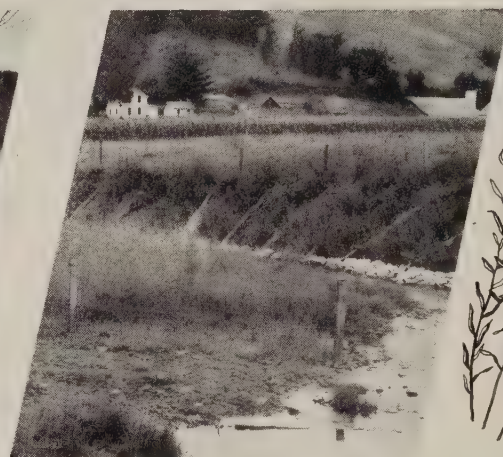
Earth dams may be protected from erosion by vegetation.



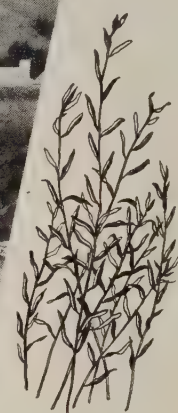
Honeysuckle



Roadside control with honeysuckle.



Streambank protection with willows.



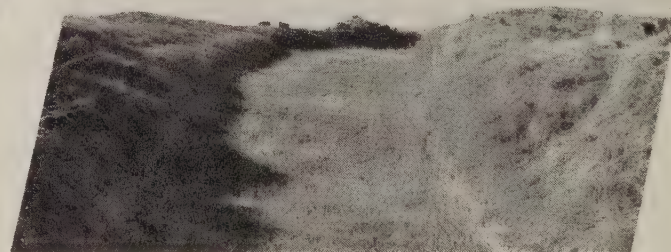
willow



Bermuda Grass



Sodded terrace outlet.



Constructed spillway protected by vegetation.



Gully converted into vegetated waterway.



Kentucky Blue Grass



Lespedeza Strata

SOIL CONSERVATION



CLAUDE R. WICKARD
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

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CRESTED WHEATGRASS IN COMPETITION WITH THE NATIVE GRASSLAND DOMINANTS OF THE NORTHERN GREAT PLAINS

By B. W. ALLRED¹

THERE appears to be a general agreement among authorities that crested wheatgrass (*Agropyron cristatum*) is the most versatile grass used in the revegetation of abandoned farm lands in the Northern Great Plains. The adaptability of this grass is borne out by a mass of experimental and observational data accumulated in 42 years on the dry-land experiment stations and private farms and ranches of the Northern Great Plains. Most of the information relative to the value of this grass has been obtained since 1920.

Old established stands have lasted through the disruptive, single or compound influences of drought and insect depredations, with no significant losses. Thousands of acres of new and thriving stands of the grass, outnumbering many times the acres planted to other grasses, have been grown in the last decade. Crested wheatgrass is now the undisputed champion of all grass species planted in the Northern Great Plains for the purpose of reclaiming barren cast-off farm lands. The Soil Conservation Service alone has established over 150,000 acres of crested wheatgrass in the last 5 years and many thousand acres more have been established by other Federal agencies, farmers and stockmen.

During the 42 years since crested wheatgrass was first introduced to the Northern Great Plains, placed under experimentation and finally put to practical use, there have accumulated many criteria regarding its limitations and productivity on abandoned farm lands. There is, nevertheless, much yet to be learned about it

and its potential ecological niche in the Northern Great Plains. One of the greatest, most important and universal questions concerns its propensities for migrating into and replacing the native grassland dominants. This highly mooted question has ardent supporters on each side. The substance of such debate is based on more than whimsical tendencies for callow argument, for, if the major replacement of the great climax grasslands is threatened by this more productive foreign invader, such a plant revolution would portend highly implicative adjustments in the grass-livestock equation. Some of the significant factors bearing on this point are mentioned in this discussion.

Crested wheatgrass was introduced to the United States by the Department of Agriculture in 1898 through the efforts of N. E. Hansen of the South Dakota Agricultural College, while he was engaged in plant exploration work for the Department in Russia and Siberia. The grass is native to the rigorous, cold, dry climate of the steppes of Eurasia. In the Northern Great Plains it found a habitat quite like its homeland in Eurasia and, consequently, few naturalization processes were necessary.

From its introduction in 1898 until 1915, crested wheatgrass was tested in minor plots over much of the West, but it was given lukewarm attention and led a neglected or orphaned existence. In fact, no record is available as to the outcome of the plantings made from the 1898 seed importations. Present records indicate that all of the crested wheatgrass now growing in the United States originated from seed importations dating 1906 or later.

¹ Chief range conservation division, Soil Conservation Service, Northern Great Plains Region, Lincoln, Nebr.

The species began drawing the interest of western agrostologists contemporaneously with the 1915 plantings at Mandan, N. Dak., Moccasin, Mont., and the University of Saskatchewan in Canada. By 1930 it had been tried at most experiment stations in the Northern Great Plains of the United States and Western Canada, and plant breeders had done much to qualify it for the important role it is to play in helping reclaim the forsaken farm lands left to be preyed on by erosion during the parlous decade of 1930 to 1940. During that period thousands of acres of these lands in the Northwestern United States have been seeded to crested wheatgrass by various Federal, State, and private agencies. Similar seedings have been made by the Dominion Government in Canada on thousands of acres of eroding abandoned fields and now many of these areas have been converted into productive communal pastures for the livestock of remaining farmers and stockmen.

A Significant Role

The following discussion is a compendium of facts pointing out the significant role ascribed to crested wheatgrass in the economy of the Northern Great Plains.

1. Crested wheatgrass had undergone sufficient experimentation and field testing by 1930 to prove its value as a forage plant in the Northern Great Plains and Western Canada. This occurred at a propitious time, for with the simultaneous occurrence of the great economic upheaval and drought of the decade, 1930 to 1940, approximately 25,000,000 acres of former wheat and feed cropland in Western United States was abandoned. These neglected lands were left to the caprice of erosion and with no ready sponsor to flout the elements that were conniving against their proper use. Immediately, there was needed for these lands a quick-growing perennial forage plant capable of producing abundant viable seed and hardy seedlings and mature plants with the hardihood to withstand weed competition, drought, insect depredations and other rigors of the Great Plains habitat. Crested wheatgrass does not have all these qualities to perfection, but it comes nearer having them than any other grasses used. Some plantings have failed entirely but many others have been successful, and there are now thousands of acres of vigorous stands that are producing both seed and forage.

2. Crested wheatgrass thrives in the cool temperatures of the Northern Great Plains and no winter killing is recorded from even as far north as the

Canadian Provinces. Its winter hardiness is attributable to the fact that it is derived from the circumpolar genus *Agropyron* and is the Eurasian ecological equivalent of the bluestem wheatgrass (*Agropyron smithii*) of the Great Plains, with which it also has a close botanical relationship. It is northerly in derivation and consequently has early spring growing habits. The dry-land sedges, common to the Northern Great Plains, notably *Carex filifolia*, *Carex heliophylla*, *Carex stenophylla* and other grass-like forage plants related to this group, green up at approximately the same time as crested wheatgrass. It usually begins to grow during the last few days in March or the first 10 days in April, depending on seasonal and site variations. The grass species that have somewhat parallel growth periods with crested wheatgrass are junegrass (*Koeleria cristata*), and Sandberg bluegrass (*Poa secunda*). They start growth at about the same time, but the two native grasses mature about 2 to 3 weeks earlier than crested wheatgrass. The latter starts about a week to 10 days ahead of bluestem wheatgrass and needle-and-thread grass (*Stipa comata*), the codominant mid-grasses of the climax grassland formation. Blue grama (*Bouteloua gracilis*) and Buffalo grass (*Buchloe dactyloides*), two of the short-grass components of the Great Plains climax, begin spring growth from 3 weeks to 6 weeks later than crested wheatgrass.

The early spring growing tendencies of crested wheatgrass give it economic significance in the part it plays in the grazing management of the grasslands. As previously stated, the dry-land sedges have vernal tendencies equal to crested wheatgrass. They are also highly nutritious but do not occur extensively enough to supply the demand for early spring forage. Junegrass seldom ranks importantly enough on ranges to contribute satisfactory yields of forage, and Sandberg bluegrass fluctuates so radically with the vagaries of weather that it is undependable and is not of much importance in forage types that are properly managed. Bluestem wheatgrass and needle-and-thread grass furnish excellent amounts of early forage when ranges are properly managed, but too often the ranges are grazed to the point where these mid-grasses are forced out to the advantage of the short grasses which persist under greater stresses of grazing than the mid-grasses.

3. Crested wheatgrass in its present role has filled two significant gaps: First, it has occupied and given protection to wasting farm land and, second, it is fitting ideally into a needed pasture rotation program by supplying an abundance of early forage which the native midgrasses are frequently not supplying because



This is a June 1939 view of a crested wheatgrass field which was planted in saltgrass in September 1938. The crested wheatgrass has developed a thrifty stand and is heading out.

they have been either eliminated or their vigor has been impaired.

4. Crested wheatgrass adapts itself to varying soil types. It is known to thrive on glacial sands and sandy loams at Huron, S. Dak.; on the Pierre soils of Winner, Ardmore, Belle Fourche, and Pierre, S. Dak.; and on the gravel soils of Fort Collins, Colo., and Judith Basin, Mont. It produced a vigorous stand on raw Tertiary shales used in the earth fill of a stock pond at Lander, Wyo., where it was planted to replace riprap on the upstream side of the fill. It has served admirably for this purpose.

5. Crested wheatgrass ranks equal to, or better than, smooth brome (*Bromus inermis*) and slender wheatgrass (*Agropyron pauciflorum*) in chemical composition and generally outyields both in hay production in the drier plains where rainfall is between 12 to 17 inches.

6. Crested wheatgrass is a prolific seed producer with yields varying from a few pounds in dry years to 700 pounds per acre in exceptionally good years. It has been known to yield as high as 1,400 pounds per acre on subirrigated lands at Bozeman, Mont. Most commercial productions average less than 300 pounds per acre. In this regard, it is superior to other common species. The seed is easily harvested and threshed with ordinary farm equipment.

7. Crested wheatgrass has a most efficient root system and outyields native and exotic grasses in root

production. Its production of roots is double that of slender wheatgrass in both weight and depth of the main root mass. These are admirable qualities in the Northern Great Plains where efficient water-using and soil-binding plants are necessary. It develops a wide-spreading root system which occupies both topsoils and subsoils. The roots in the topsoils spread uniformly in all directions from the crown. This characteristic root growth habit, combined with its early growth, makes for a most impregnable defense against weed competition.

8. Crested wheatgrass is quite resistant to stem rust and ergot and particularly excels slender wheatgrass in this respect.

9. Crested wheatgrass requires little seedbed preparation, the main requisite being a firm seedbed which is often optimum in undisturbed stubble or weed fields.

10. Comparative grazing studies made in the Northern Great Plains on crested wheatgrass pastures and native grasslands have shown that the crested wheatgrass pastures have from 80- to 100-percent greater grazing capacity than native grasslands. However, much more intensive and broader investigations are necessary before definite long-time comparisons can be made. While a trial balance at present shows a preponderance of evidence for crested wheatgrass on the credit side, there are many factors that have to

be leveled out by diligent and extended experiments.

Crested wheatgrass has no doubt benefited from the stimulus of cultivation exerted in the process of its own establishment as well as those previous cultivations while the land was in other crops. The ultimate effect on grazing capacity at the time when the grass reaches root and stand stagnation common to native grasses is not known. Because the grass is naturally a heavy feeder on moisture and nutrients, there are many who are fearful that the plant's own greediness may bring about its early demise from consequential exhaustion of soil moisture and plant food. The extremes of these grave doubts are probably unwarranted, but it can logically be expected that the big yields common to the first few years of growth may decrease. Certainly the plant growth will always have to be in harmony with its moisture relations. It maintains this harmony because of its well-developed tendency to establish itself in a state of premature dormancy during drought. When moisture is made available, crested wheatgrass revives and quickly begins growing. The fact that thousands of acres have been established during drought years speaks unerringly for its drought-resistant qualities. Furthermore, the possibility of soil exhaustion appears far fetched since the plant is known to exist in stands that are over 25 years old in the Northern Great Plains where there is no present indication of soil nutrient exhaustion. The very fact that it is a dominant in the grasslands of the Eurasian steppes nullifies any general notion that it is destructive of soil resources.

11. Crested wheatgrass probably is not as tolerant of alkaline soils as bluestem wheatgrass but it does successfully grow on soils that are moderately alkaline, as will later be pointed out.

12. Crested wheatgrass bunches enlarge both by tillering and by new shoots originating from short lateral rhizomes. As plants mature they develop a distinctly clumpy habit, leaving the interstices of open ground exposed to erosion. Particularly on high erodible soils, it is desirable to plant with it some of the more aggressive sod-formers such as smooth brome or bluestem wheatgrass.

13. Crested wheatgrass becomes tough and unpalatable about June 15 when blue grama and buffalo grass are usually in prime grazing condition. Later when the short grasses mature in early September, crested wheatgrass is producing a palatable succulent leaf and stem for late fall grazing. Its early and late season growth habits make it a valuable asset to the livestock industry.

14. A sheepman near Billings, Mont., lambd his herd of 2,000 ewes during the spring of 1940 on a 320-acre field of crested wheatgrass near Winnett, Mont. When the actual use of this half-section is reduced to standard grazing terminology it has an equivalent of 50 animal units for an 8-month period. The sheep were moved from the grass by May 1. A June 1 inspection was made and the grass had recovered from spring grazing and was beginning to head out. It is estimated that the field will yield approximately 150 pounds of seed per acre this year. The superior production obtained on this field can be attributed largely to the superabundance of rainfall that has fallen in the area to date. The grass could not be expected to repeat this excellent performance under the average rainfall conditions of the Northern Great Plains.

An Invader of Native Grasslands

The foregoing statements indicate that crested wheatgrass ranks far ahead of the native grasses in many categories. Therefore, if such a plant revolution as the theoretical extinguishment of the native grasslands by crested wheatgrass were to take place, the losses occasioned by this exchange would doubtlessly be more than offset by the gains. Even if the superior advantages maintained for crested wheatgrass hold forth continuously and make a broad exchange of native climax grasslands for crested wheatgrass lands desirable, there are some extremely dynamic factors that would prevent such a development. There appears little likelihood that crested wheatgrass will usurp the place of native climax grasses because the natives are the true expression, in reality the end product, of the Northern Great Plains climate. They are inured to the peculiarities of this climate and are dominated by it as crested wheatgrass is dominated by the peculiar, but somewhat similar, climate of Eurasia.

The dominants of the Great Plains climax are the two mid-grasses, needle-and-thread grass and bluestem wheatgrass; and the three short grasses, blue grama, buffalo grass and threadleaf sedge (*Carex filifolia*), the latter being a sedge which is the ecological equivalent of a short grass. This group of grasses has a remarkable versatility for supplying the needs of livestock when they are maintained in proper balance. Threadleaf sedge provides the earliest spring grazing and is closely followed by the two mid-grasses and later by the two short grasses which green up in June and supply green feed most of the summer, except in drought years. Needle-and-thread grass has fall growing hab-

its like crested wheatgrass and provides green feed late in autumn when rainfall is adequate.

Although such cases have been reported, I have never seen a situation where crested wheatgrass has migrated into a climax stand of grasses or even produced competitive stands when it has been drilled in them. However, it has been known to grow or migrate into abandoned farm lands or on the bare areas in native grasslands caused by drought or other causes. My own observations and studies include only the region of the Northern Great Plains and its extension into western Canada.

The vast seedings of crested wheatgrass in the Northern Great Plains and the Prairie Provinces of Canada, made in the past 20 years, offer a most fertile field of observation. The native bluestem wheatgrass has, in many instances, made partial or complete encroachments on abandoned farm lands. Invariably, where bluestem wheatgrass has taken over, the crested wheatgrass has failed to make stands. Yet, repeated observations have shown that crested wheatgrass was outyielding bluestem wheatgrass from 60 to 100 percent in dry matter in the adjacent stands. Conversely, the native grasses have been slow to migrate into stands of crested wheatgrass although instances have been noted at Miles City, Mont., and at Swift Current, Canada, where traces of blue grama in rare instances, and considerable amounts of bluestem wheatgrass are moving into older stands of crested wheatgrass.

Crested wheatgrass originating on a pasture at Ardmore, S. Dak., has migrated 1,000 feet in 7 years on to abandoned farm land, according to V. I. Clark, acting superintendent of the Ardmore field station.

Crested wheatgrass seedings in 1938 on the native sod of the golf courses at both Roundup and Lewistown, Mont., failed. The 2 years following these plantings were highly favorable to the growth of the grass and even though the plantings were made in both fairway and rough, all failed.

Rather phenomenal results were obtained from crested wheatgrass planted on the Culbertson soil conservation project in Montana in September 1938. It was drilled into a 25-percent stand of saltgrass (*Distichlis stricta*) along the headland of a cultivated field. The results of this planting are noteworthy in that a thrifty stand of the grass had developed and seeded out by June 12 of the following year.

This may appear paradoxical in light of some previous statements made in this paper; however, there are pertinent ecological factors that can be applied to explain the situation. One is that saltgrass is not a

climatic dominant in the Great Plains habitat, but is a member of a developmental community in the plant succession of the area. Next, this particular site is in a slightly subirrigated and alkaline bottomland where the saltgrass has gained prominence because the local dominant, bluestem wheatgrass, has been eliminated by grazing. A pure stand of the latter is found in an adjacent ungrazed lot. Crested wheatgrass has a close ecological and botanical relationship to bluestem wheatgrass, and hence it seems logical to assume that in this case it is merely usurping the natural role of bluestem wheatgrass in supplying a mid-grass that is common in the climax. On this particular site, saltgrass, which is likewise a short grass, has benefited by the past grazing practices which have largely eliminated bluestem wheatgrass.

By a similar deduction, it can be readily presumed that crested wheatgrass will migrate to some extent into the short grasses once the native mid-grasses have been removed by biotic influences. These migrations will no doubt be limited to sites with naturally greater moisture equivalents, such as flood plains, swales, and ranges where the short-grass stands have been seriously reduced by various causes. Reports from men at some of the Northern Great Plains experiment stations have verified this conclusion.

General Conclusions

Crested wheatgrass appears to possess more of the superior and fewer of the undesirable qualities than the other species used in reclaiming abandoned farm lands.

Present information indicates that it does not invade and dominate the climax grasslands. It has migrated successfully into disturbance or successional communities of annual weeds. So far it has failed to produce competitive stands when drilled into established stands of bluestem wheatgrass. Crested wheatgrass has made only minor migrations into open stands of blue grama.

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A RANGE CONSERVATION DEMONSTRATION IN THE LAND OF THE NAVAJOS

By HUGH G. CALKINS¹ and D. S. HUBBELL²

THERE have now been 7 years of soil conservation research and demonstration by the Navajo Experiment Station at Mexican Springs, N. Mex. This station was one of the first to be organized under the national emergency conservation program. It has been the scene of many varied and significant research and demonstration projects relating to livestock, range management and farming in the Southwest.

Grazing of livestock is the dominant industry on the Navajo Reservation and throughout the Southwest, and therefore presents the most pressing land-use problems. Demonstration of proper grazing and management practices, together with the use of improved livestock is important to the Navajo Reservation livestock program and to Service planning and operations in Region 8.

The research program, which is of particular significance in the long run, is still in the midst of studies which will require more time for completion.

BOULDER DAM, it is said, was partly responsible for establishing the station at Mexican Springs. A large proportion of the silt pouring in behind this costly structure was traced to the San Juan drainage, much of which lies within the Navajo Reservation.

When this siltation, together with the rapid rate at which erosion was destroying Navajo ranges, was brought to the attention of John Collier, Commissioner of Indian Affairs, early in 1933, he asked for an investigation of erosion conditions on the Navajo Reservation.

H. H. Bennett, W. C. Lowdermilk, C. K. Cooper-rider, C. E. Ramser, and others undertook to make that investigation. A site was picked where erosion and erosion-control methods might be studied. With permission of the Navajo Tribal Council an agreement was drawn up July 14, 1933, under which was established the Navajo Experiment Station. A few months later, with the creation of the Soil Erosion Service, Mexican Springs was transferred to the new agency as its first official experiment station.

A SMALL but almost complete watershed, typical of the Navajo country, the 60,000-acre area under study ranges from an elevation of 8,120 feet on the high

western watershed divide to 6,200 feet in the lower eastern portions. Average annual rainfall records are available only since 1934. They show precipitation in the lower portions of 7.5 inches; in the upper reaches, 18 inches.

Owing to the preponderance of foothill and mountain topography, shallow residual soils, and deeply filled alluvial valleys, the area is susceptible to severe, accelerated water erosion. Since this is characteristic of much of the Southwest, Mexican Springs findings as to erosion control and run-off have been found applicable to many other parts of Region 8.

WHEN the station was established there was little information for the Southwestern range country, on action of silt and run-off, and on erosion control measures. During its early years, therefore, almost every conceivable erosion control measure was given a trial, and silt and run-off were studied.

In the past 2 years the station has narrowed its research activity to two main groups—diversion flooding and run-off from complete drainage areas.

In the run-off studies, nine representative drainage areas under controlled grazing, and three outside the area, under common use, are systematically studied. The largest drainage area comprises 46,000 acres, and the smallest only 187 acres.

Rain gages and recording stream-flow gages are spotted at strategic points throughout these drainage areas so that the amount and intensity of rainfall, the storm pattern, and the run-off can be adequately recorded. During actual flows, samples are taken and analyzed for silt and salinity. Data are correlated with the amount of run-off, the duration and pattern of the storm, and the vegetative and grazing factors involved, to get the whole picture of how much silt and water can be expected from a certain type of country with a certain kind and amount of rain.

These studies yield data helpful in determining the relation of run-off to rainfall—information essential to proper designing of erosion and flood control structures and useful for guidance in watershed treatment.

Possibly of more immediate interest are experiments in the field of diversion flooding. Flood waters are taken out of arroyos and spread on crop and range lands, in an effort to develop methods effective in the stabilization of soils and the conservation of water.

For studying the effects of flood waters on soil and

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Acoma stock owners watch branding and dehorning operations in May, when cattle are rounded up in the drive from winter to summer ranges. Juniper woodland characteristically surrounds the corral.

vegetation, field and plot studies are under way. While no control is exercised on water flow in the field studies, water reaching the plot studies is controlled as to amount, or kind, or both.

In the plot studies, the smaller plots, all planted to native grass, are divided into several series, which receive controlled mixtures of water and silt; amount and kind of silt varying with the series. Of the larger plots, each $\frac{1}{100}$ acre in area, some are planted to native grasses, the others to crops. Certain of the grass plots receive a 6-inch application from every flow coming down Mexican Springs Wash; some receive clear well water; still others receive only rainfall. The crop plots are divided into series to test the effects of applying to certain ones portions of each flow coming down the wash, and of applying to others, flows selected for timeliness and for silt content.

Measurements are made of crop yields, quantitative and qualitative changes in vegetative cover, and physical, chemical and bacterial changes in soil, to determine the effects of the various treatments.

AS AN important phase of the broad program designed to prevent excessive soil and water losses through accelerated erosion, a livestock and range management demonstration was undertaken on the

43,000-acre area under fence. This demonstration was designed not only to test methods in rehabilitating range lands but also to find what effect reducing grazing to intensities commensurate with the existing vegetative cover would have upon the income netted by the area.

Because the area had been heavily overgrazed prior to the establishment of the station, the first step was to reduce to proper numbers the Navajo sheep, cattle, and other stock grazing within the station boundaries. After the area was fenced, all livestock was removed. Surveys showed the estimated carrying capacity to be 1,854 sheep units. This amount of stock was returned to the area for study and demonstration of proper livestock and range management.

Of the 1,854 sheep units, 500 are now purebred Rambouillets, and 500 are mixedbred Navajo sheep. Purebred Hereford cows make up 320 sheep units, and 534 sheep units are in miscellaneous stock such as horses, rams, stallions, and bulls.

In addition to records on the livestock within the area, the station staff has also kept records on yields and returns from typical livestock outside the experimental area.

For comparing results under proper management



Badly overgrazed Laguna reservation range is slow to come back. Sacaton grass beyond fence is far from back to "original condition," but one growing season without grazing has given it a lush appearance compared with that of the annuals outside the fence. Stock was excluded, water was spread, to aid natural vegetation.

within the area with results under ordinary Navajo management outside the area, the former number of sheep units grazing the area was estimated to be 3,700. This is based on the fact that the station was located within, and was typical of, district 14 of the Navajo Reservation, where range surveys and livestock counts showed that the estimated carrying capacity was 50 percent of the total number of stock grazing within the district.

The management program includes use of range by both cattle and sheep because (1) the Navajos around Mexican Springs originally had a few beef cattle in addition to sheep and wanted to continue some dual usage, and (2) flood irrigation tests and erosion control treatment afforded range that could be used more efficiently by cattle than by sheep.

The program to improve Navajo sheep has been planned as part of the operations demonstration work upon the Navajo lands. Earlier studies by the Indian Service indicated that erosion control was intimately related to a more efficient production of mutton and wool. This program calls for the use of high quality rams and the careful culling of each flock. It does not contemplate selective breeding for new types, such as that carried on at Fort Wingate by the Bureau of Animal Industry and the Indian Service. A flock of purebred sheep has been grazed in the area for the 5-year period, 1935-39. The mixedbred sheep of the Navajos, however, were introduced to the station range less than 3 years ago. The period 1937-40 has been too short for the breeding improvement program to bring results in increased production. The mixedbred sheep inside the area are, so far, of about the same quality as the mixedbred sheep outside.

The following tables of results therefore reflect, for the mixedbred sheep inside the area, production

increases due only to reduced stocking and proper management.

Production records of the Rambouillets show that the Navajos can run purebred sheep and, with proper management and curtailed numbers, boost their income as much as 37 percent per acre.

Data are not yet available to show how long it may take for the income of the properly managed Navajo herd, through careful breeding, to approach the purebred herd income. With careful teaching of breeding and culling practices, it is hoped, however, that this point may be reached in 10 years.

The station does not anticipate that all Navajos will have purebred sheep. It does, however, expect that the ordinary Navajo sheep will be vastly improved in type.

In the demonstration the Indians have been handling the native mixedbred stock themselves, paying all bills and buying salt.

Tables 1 and 2 illustrate the effect on yield and return of proper livestock management.

TABLE 1.—Yields from Navajo mixedbred sheep and purebred Rambouillets

	Ewes	Lamb crop	Average fleece weights	Average lamb weights	Average death loss
	Number	Percent	Pounds	Pounds	Percent
Mixedbred sheep inside area*	500	75	5	55	6
Mixedbred sheep outside area*	500	55	4	50	15
Purebred sheep inside area**	500	92	11	64	6

* Records for 1937-39.

** Records for 1935-39.

In 1935, Navajos in the Mexican Springs area purchased a herd of purebred Hereford cattle from the drought area of western Texas. In 1939 the cows were pooled into an owners' association, with each

TABLE 2.—Returns from Navajo mixedbred sheep and purebred Rambouillets

	Average price per pound		Gross return per ewe
	Wool	Lambs	
	Dollars	Dollars	Dollars
Mixedbred sheep inside area*	0.174	0.0615	3.40
Mixedbred sheep outside area*	.174	.060	2.33
Purebred sheep inside area**	.190	.073	6.39

*Records for 1937-39.

** Records for 1935-39.

owner issued shares in the total herd. The Navajos paid for these cattle out of the herd's increase, and, since the formation of this association, records on cattle yield and return have been kept. Improved range and livestock management shows increased returns in beef production as well as in lamb and wool production, as shown in table 3.

TABLE 3.—Yields and returns from Navajo cattle of fair grade and purebred cattle, 1939

	Ma- ture cows	Calf crop	Death loss	Aver- age calf weight	Aver- age price per pound	Gross return per cow
	No.	Pct.	Pct.	Lbs.	Dols.	Dols.
Purebred cows inside area	50	94	2	462	0.09	38.25
Grade cows outside area	40	60	0	350	.06	12.60

Since part of the station area has dual usage (cattle and sheep) the gross returns may well be figured on that basis. The average gross return for all livestock, converted into sheep units, is \$6.45 per sheep unit. On the other hand, the gross returns for sheep and cattle on the Navajo range outside the area is \$2.74 per sheep unit. However, because of the reduction from 3,700 units to 1,854 units within the station's range area, the unit gross income inside should be compared with the gross income from two units outside. This makes gross return per unit inside the area \$6.45 as contrasted to \$5.48 outside. In other words, the Mexican Springs Navajos have earned more from 1,854 sheep units properly managed, and under dual usage, than they would have from 3,700 sheep units, had no reduction or management changes taken place within the area.

On an acreage basis, the Mexican Springs Navajos earned 15 percent more where livestock was properly managed and under dual usage than did those outside the area. The gross returns show that the Mexican Springs area produced 16 cents per acre as compared with 14 cents per acre outside, on the same number of acres with twice the stock.

In other words, the Navajo Experiment Station is

beginning to show the Navajo stockmen that their livestock income can be maintained and possibly increased, under a system which protects and improves their chief resource—range land.

Equally as significant as the yield and return statistics is the recovery within the boundaries of the station. Gullies, with little or no special treatment have generally healed, their bottoms and sides have become stabilized by grass. Well-sodded western wheatgrass and blue grama slopes contrast sharply with bare, eroding soils outside the area where the chief perennial vegetation is scattered clumps of snakeweed and pingue. There is evidence that the carrying capacity of the area has increased, possibly doubled, in portions of the higher rainfall belt and in flood-irrigated areas.

If it had done nothing else, the project would be well worth while for its demonstration of the value of proper grazing practices in erosion control.

TZINTZUNTZAN TO SINGAPORE

(Continued from p. 57)

those in the eroding fields had fallen far below yields obtained from the non-eroding field, which has held up to its original output.

When I asked the farmer how much the conservation work had reduced erosion in the eroding field, he replied without hesitation, "Ninety-eight percent."

Our visit to that part of Michigan ended that night with the crowning of Miss Barbara Brown, of St. Ignace, as Queen of the National Cherry Festival. Since then my thoughts occasionally have skipped back and forth from the drifting sands and eroding fields and orchards cultivated up and down so many of Michigan's slopes to the gullies of Tzintzuntzan and the benched slopes south of Mexico City. What comes of this mental skipping from field to field across the Rio Grande is the conclusion that when we fail to defend our productive land, we eventually lose by that neglect our heritage of productive soil—the foundation of liberty, happiness, prosperity, and national virility and security.

With the kind of cooperation I found in Michigan—the fine teamwork among farmers and specialists, both Federal and State—I am confident that the good work we saw in fields and orchards, on drifting sands and eroding slopes, is going to be carried steadily forward toward our goal of security for the land, and the people, and the Nation itself.

POSSIBILITIES OF JOHNSON GRASS IN NORTHWEST TEXAS

By HENRY M. PEVEHOUSE ¹



Stubble of a good stand of two-year-old uncultivated Johnson grass on sandy soil heavily grazed with sheep in 1939. This picture was taken in March 1940 after three severe dust storms, one of 36 hours' duration.

JOHNSON GRASS, which in many areas is considered a serious pest or a pernicious weed, may prove to be a great boon to agriculture and an important addition to the grazing economy of the livestock-feed-grain area north of the Canadian river in Texas. While distributed through 33 States it has never been common to this area and it is most prevalent in the South.

Many States have passed stringent laws regarding the selling or transporting of Johnson grass seed, the planting of the grass or allowing it to go to seed, sometimes even penalizing the very existence of this grass on lands owned by individuals, corporations, or others. The Oklahoma law, for example, provides that failure on the part of a person or corporation owning or controlling land to remove Johnson grass from such land within a specified time after being served with a notice of complaint subjects him to a fine and penalty. Furthermore, the county commissioners may then enter the property, remove the grass and charge up the cost thereof in the form of a tax lien. Kansas has a law against selling the seed but does not prevent its being planted. Texas laws are especially directed toward irrigation companies and railroads allowing the grass to go to seed along their ditches or rights-of-way, but Texas does not prevent the selling of the seed or the planting of it on one's own land.

This article describes the growth and utilization of the grass in the area centering around Dallam and Hartley Counties, Tex. Here there is an urgent need

for a perennial cultivated or semicultivated plant which combines the advantage of being a good soil binder with that of having satisfactory economic possibilities. Johnson grass seems the nearest approach to such a plant yet found.

Physical Characteristics

Johnson grass (*Sorghum halepense*), a highly palatable perennial grass native of the Mediterranean area, belongs to the sorghum tribe of cultivated grasses. It resembles Sudan grass in appearance and, although it does not usually grow as tall, it may be distinguished from Sudan by its root stocks which are about the size of an ordinary lead pencil. These regenerative roots, or rhizomes, which cluster under the crown of the grass and lie dormant during the winter season, extend down and outward from 1 to 4 or 6 feet. They are jointed in 1- to 2-inch sections and at each joint may send out either small fibrous feeder roots through the soil, or grass shoots above the surface, or both. Thus, any root when partially or wholly covered with several inches of soil and consisting of two or more sections with an unimpaired joint, may in favorable weather take root and send up stems or shoots. Farmers who have had from 6 to 10 years' experience in growing the grass in this area report that this root clump, when once started and if left undisturbed, will multiply and spread underground, take root at each joint and send up shoots from as many of the joints as is necessary to sustain life and balance growth of the root clump below the surface.

The shoots or stalks grow rapidly in normal weather, and if unmolested they will make seed within 60 to 75 days in this area. Climatic conditions, however, especially moisture, are not always favorable to full maturing of seed; hence, indications are that the grass will spread very little through volunteer seeding.

One of the marks of a good erosion-resisting plant is the nature of its root system and its ability to hold the topsoil. The extensive and tenacious root system close to the surface and the large amount of top growth make Johnson grass a good soil-binder and soil-builder. If cultivated frequently after being established, Johnson grass will resist erosion on all types of soil. It need not be disturbed by plowing until after the worst windstorms of March and April. Even then listing or chiseling, the most common methods of

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tillage for erosion control in this area, are the methods generally used in cultivating Johnson grass.

Old uniform stands of grass which have been cross-listed for root distribution furnish good grazing and show almost a solid ground cover. This cover, even when grazed very closely, is sufficient to prevent damaging wind erosion even on the sandier soils.

Seeding and Harvesting

Johnson grass may be established from the rhizomes, but the cost of extensive establishment by such practice would probably be prohibitive. In this area, the grass usually is started from seed, and during the first year of growth it is known as seedling grass to distinguish it from grass sprung from the rhizomes.

Seeding of Johnson grass is at the rate of about 5 pounds per acre, planted with a lister 3 to 4 inches deep in 36- to 42-inch rows. Planting is usually from June 1 to June 15. Normally, seedling grass is cultivated once for weed control. If it is to be harvested for seed, two cultivations may be in order. Once established, the grass will come up from the root stocks every year thereafter. If not plowed or broken up occasionally, the grass tends to become "rootbound" and dies out gradually after 3 or 4 seasons. This is especially true on clay soils. Therefore, for best growth and also for weed control it should be broken up or listed every second or third year, preferably at right angles to the previous listing or planting, to obtain wider distribution of the roots. Some farmers plow Johnson grass every spring just after it starts coming up. It thrives better under such treatment and, furthermore, the first crop of weeds is killed.

To harvest for seed, the grass is mowed, raked, and stacked, or it may be cut with a binder. The seed must be fully matured before cutting. If harvested for forage or silage, Johnson grass usually is bound at about the time it is fully headed out, but before the seed begins to ripen. At this stage, it is more palatable because it is greener and less stemmy. In this area harvesting is by grazing.

Production and Utilization

Johnson grass which has become well rooted in previous seasons will sprout out in late April or early May. Within 10 days (weather permitting) it will be from 2 to 5 inches high and ready for grazing. Grazing starts around May 15. Grass 2 to 5 years old which has been spread by cultivation will furnish from 2½ to 7 cow months of pasture per acre. While the best grazing season is from May 15 to September 30, cattle and horses will eat it, especially the lower leaves close

to the ground, as long as it stands, which may be as late as January 1.

During the growing season the grass will withstand heavy grazing. Cattle, sheep, and horses prefer the young tender shoots or stems to older grass. If these stems are cut or grazed off during the growing season, they sprout or sucker out again immediately and in favorable weather may grow as much as 2 inches within a 24-hour period. If a field appears to be suffering from overgrazing, removing the stock from it for a week or 10 days ordinarily brings full recovery. In exceedingly dry weather from 2 to 4 weeks' rest, or a light shower, may be required.

Because of its slow growth, seedling Johnson grass is more difficult to establish than other sorghums. Even seedling grass that is well established will furnish scarcely one-half as much grazing during the first year as will old root-sprung row stands, and probably only one-fourth as much as old well-scattered, cultivated stands. A seedling field west of Dalhart, Tex., produced 350 pounds of cleaned seed per acre in 1939, the highest yield recorded in the area. Being less vigorous and less highly competitive during the early stages of growth, Johnson grass does not thrive when seeded in a mixture of Sudan, cane, and other sorghums.

As to forage production, good, old stands of Johnson grass produced as much as 1,000 bundles, or about 5,000 pounds of dry forage per acre in 1939. One field of mixed cane and Johnson grass produced 6 tons of silage per acre and, in addition, 4 to 5 cow months of pasture per acre, later in the season.

Inasmuch as Johnson grass in this area usually is planted on abandoned or badly eroded cultivated fields from which little if any economic return has been expected, still less realized, any appreciable returns beyond expenses are welcomed. Individual experiences with the grass have been highly satisfactory.

Cecil Jones of Dallam County reports the equivalent of 2 cow months of sheep pasturage per acre on 540 acres of second-year, uncultivated grass. His lambs made total net gains of 62½ pounds per acre, which at 6 cents per pound grossed him \$3.75 per acre. Mr. Jones' sheep grazed on a section which contained 100 acres of native grama and 540 acres of Johnson grass. The sheep, having access to both, grazed the Johnson to the ground, but allowed the grama to head out. On 120 acres of 5-year-old grass which had been listed several times, including once in 1939, 120 yearling steers grazed for four months, and, later, 100 head of cows for 2 months. The steers without any other feed gained an average of 250 pounds, or more

than 2 pounds per day. They weighed around 700 pounds when sold from the field and topped the market at 8 cents—a gross of \$20 per acre. This was on good, deep, sandy land with more than average moisture. It seems probable that Mr. Jones permitted too close grazing of this field. This is partially substantiated by the fact that the grass came out slowly and thinly in the spring of 1940. However, a hard freeze on April 12, 1940, resulted in severe damage to the rhizomes, and set the grass back at least 30 days.

Grover Swift filled a 640-ton trench silo from a 160-acre field planted in 1939 with a seed mixture of three-fourths cane and one-fourth Johnson grass by weight. Immediately after cutting, this field furnished the equivalent of one-half-cow month of pasture per acre. While the Johnson grass forage production was negligible compared with the cane, a thin but evenly distributed stand was obtained. This planting procedure will be continued according to Mr. Swift, until a satisfactory stand of Johnson grass has been obtained, at which time the field will be scalloped, disked or listed once or twice each year and utilized for grazing.

The same year Mr. Swift also planted to Johnson grass 2,560 acres of severely eroded land that had been abandoned a number of years. Four pounds of seed per acre were planted in 42-inch rows with a lister. A fair stand resulted. Mr. Swift intends to continue to replant and work this land until the soil has been completely stabilized with a cover of Johnson grass, after which he will use it for pasture.

Mr. Vinson, of Hartley County, grazed 90 head of mixed cattle for 7 months on 90 acres of 4-year-old grass, which was cultivated in 1938 but not in 1939. Many others realized from 2 to 5 cow-months of pasturage per acre, depending somewhat on the condition and the age of the grass and the manner in which it was utilized. Some farmers grazed their grass very close, never allowing it to grow more than 8 to 10 inches high. Others used the grass less intensively, allowing it to attain a height of 2 to 4 feet, to get stemmy and to head out. The former practice will produce best results, as the grass is more palatable when young and tender.

Due to a mild winter and adequate seasonal moisture early in the spring of 1939, Johnson grass as well as all other sorghums probably made better than average growth throughout the year.

Johnson grass does best in this area on deep sandy soils with the normal 14- to 18-inch rainfall. It will, however, produce satisfactorily on heavy loam soils and with less rainfall. Indeed, it is noteworthy for

yielding worth-while returns under conditions of rainfall which would discourage annual sorghums. This is evidenced by the fact that Johnson grass did well here during the period 1934-39 inclusive, when the average annual rainfall at Dalhart was 12.72 inches.

Use Limitations

Because of the difficulty of eradication, Johnson grass is not recommended for use on any land which is later to be cultivated regularly to annual crops. The tenacity of the root system in maintaining the grass after it has been established in this area has not been fully measured; it is likely however, that extreme and costly methods of eradication such as deep plowings in the hot dry summer months, or plowing in the winter when the roots can be turned up and allowed to freeze, would be necessary to kill it out. Johnson grass is not recommended on lands where wheat or other grain crops are being grown successfully.

Johnson grass planted on shallow, poor soils and shallow-phase silt and clay loams is difficult to maintain even under the most favorable circumstances. Furthermore, in this area Johnson grass is not a permanent perennial, as it is in more humid climates. Here it is a semi-cultivated crop, and unless the roots are broken up and scattered occasionally they tend to become root-bound and make little if any growth above ground. On the other hand, although all of the roots may then appear to be dead, many are in reality only dormant and will start growing if disturbed. Thus, if the ground is broken up during the spring and seeded to annual crops, the Johnson roots will immediately sprout out, use up the moisture in the soil, hinder the growth and necessitate more cultivation of the annual crop.

Some caution is necessary in grazing Johnson grass to prevent losses of livestock from poisoning. The consensus of opinion of agronomists and other technicians regarding the danger of prussic-acid poisoning from the grazing of Johnson grass is that the danger is no greater than that from other plants of the sorghum tribe. In 1939 only one record of poisoning was found in this area, whereas several farmers lost cattle from poisoning by native plants. While little is actually known concerning the formation of toxic acid by plants, it is now thought that Johnson grass will develop this acid in the wilt stage during a hot dry spell. Some farmers who have had experience with Johnson grass claim that it is reasonably safe to graze it after it greens up again following a drought period.

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SIZE OF FARM AND THE SOIL CONSERVATION PROGRAM

By GEORGE W. COLLIER ¹

INCREASING the size of farming unit sometimes becomes a vital part of soil conservation. Large numbers of farms are too small to return an income adequate to meet minimum standards of health, education, and individual and community well-being. Small farm sizes have tended to use the land to increase current revenues at the cost of long-time production and income. Besides encouraging a land use resulting in a wastage of soil, small farming units have made it necessary to use for living purposes that part of the income which, to prevent future declines in production, should have been spent for soil-conserving practices.

It is shortsighted to formulate farm plans which result in inadequate incomes. Such plans manifestly cannot be adhered to indefinitely—neither can even the low incomes provided be kept from dropping further in the face of continuously depleted resources. The ideal should be to formulate farm plans resulting in adequate incomes which are maintainable over a period of years. Such planning naturally is based on a conserving use of land resources.

The making of conservation plans without attention to minimum income possibilities is similar to building a dog kennel to house a horse. A conserving land use and an adequate farm income are essential to a lasting farm plan.

Sometimes, it is true, the volume of business and the income can be increased without adding to the size of farm. Even with a reduction of cultivated land or of acreage of the highest value crop, there is oftentimes an opportunity to intensify the organization in other respects. Yield per acre of the reduced crop acreage may be increased by more intensive cultural practices, or crops and livestock may be shifted to types of production that are more intensive in use of labor, fertilizer, etc. For instance, dual-purpose cattle and chickens might be increased to offset decrease in production of fat cattle and hogs; or, a small acreage of canning and truck crops might replace part of the corn. Only where such opportunities are not present does it become imperative that farm size be increased to maintain both income and land resources.

While the size of business on small-farm enterprises should be intensified wherever practical, there are

many instances wherein enlargement of units is desirable. More skill in management is usually required to operate intensively a small unit than to practice the usual type of farming on a larger acreage. The general increase in volume of business on small units would result in a more difficult marketing problem than that resulting from increased volume of business brought about by enlarged farm boundaries.

In many areas in the United States, acreage per unit seems to be directly associated with productivity per acre—the better the land the larger the farm, or, conversely, the poorer the land the smaller the farm. A greater change in land use is often indicated on small farms of low productivity than on larger and more fertile farms. Moreover, this change often causes a relatively large sacrifice of current income that is already very low, in order to maintain that income over a longer period. In such instances, size of farm has been a major factor in harmful exploitation of soil. Conservation will not be achieved on such farms until unit sizes are increased or farm incomes are supplemented in some other way.

In many sections of the country land use is not suited to soil and climatic conditions. Although this is especially true in the Great Plains, particularly in the Northern Great Plains, it is by no means confined to this region. In many areas the small size of the farm has forced the farmer to practice more intensive farming with more land in cultivated crops over a period of years than is justified by the soil and climatic environment. While in favorable years this may produce much more income per acre than would a more conservative use of the land, in unfavorable years it is hazardous from the point of view of both current income and loss of soil resources by erosion.

In the Northern Great Plains, the effect of a cash-crop system has often been such as to cause soil losses by erosion in unfavorable climatic seasons. Often it is impossible to initiate an effective soil conservation program without greatly decreasing acreage of cultivated land; and where size of farm is geared to production of cultivated crops, the farm may not be large enough to afford adequate operations under a grazing system. Thus, if income is to be maintained, change in type of agriculture will necessitate increase in the size of many farms. The Bureau of Agricultural Economics recognizes the need of increasing farm-

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unit size in the Great Plains in order to increase and stabilize farm income and maintain land resources. The Bureau reports as follows:²

Many of the farms in the Great Plains have been found too small to provide a sufficient surplus in good years to carry them over the inevitable bad years. Small acreages have also contributed to erosion problems since on the small farms there has been a tendency to place too large a proportion of the land in crops, leaving the soil unprotected against wind erosion.

Permanent rehabilitation of farmers would involve an increase in the size of some farms, retirement of some land from crops, an increase in pasture acreage, immediate or eventual replacement of depleted livestock herds, repairs to buildings, and repairs or replacement of machinery.

The county planning report for Hill County, Tex., where attention has been given to farm sizes, recommended that the number of farms in the county should be reduced by 23 percent. For specific subareas within the county the recommendation varied from no change to an average of 50-percent increase in size.

The 1939 annual report for the Northern Great Plains Region of the Soil Conservation Service (p. 22) states that:

Probably 50 percent of the operating units in soil conservation district work areas are of an inadequate size to organize the farm for sound management and still enable the farmer to obtain an adequate income without additional assistance. * * * In many respects tax-adjustment, debt-adjustment and adjustment in size of operating units are almost required preliminaries for the execution of a sound soil conservation program.

Although need for increasing farm unit size has been most closely associated with areas of hazardous climatic conditions, it exists also in the humid regions. Ohio Agricultural Experiment Station Bulletin 604, "The Relationship Between Soil Maintenance and Profitable Farming," reports a study of 10 areas in that State showing that "there was a tendency for larger-than-average farms to have a better productivity balance than small farms. In other words, owners of small farms generally find it necessary to have a high proportion of their land in soil-depleting crops."

Missouri Research Bulletin 308, "Relationship of Productivity of Farm Units and Their Ability to Pay Rent," points out that "a farm unit must exceed a certain minimum size and a certain level of productivity if it is to provide a living for the farm family and pay the cash costs of production." A unit might have "just enough physical production to supply an adequate living and pay the necessary variable and fixed expenses but give no net return to the landlord." The fact that a farming unit is too small to pay rent does not mean that the land is submarginal in productivity.

It does mean that such a farming unit will not provide a living for the operator, pay cash expenses and rent, and is therefore submarginal on account of size.

The above quotations for Ohio, Missouri, and the Great Plains, together with similar evidence in the Southeast, show that the need for increasing size of farm represents an obstacle to conservation planning in several parts of the country. Many farms too small to allow formulation of a plan to produce adequate income and maintain resources could be planned as part-time farms. Unfortunately, however, thousands of such farms do not have employment opportunities for supplementing the small incomes from their land resources, and in the attempt to increase immediate income by exploiting the land they reduce subsequent production and income to a still lower level. If conservation of land resources is to be achieved it is important in several regions that ways and means of decreasing size of farm be considered.

In many areas where it is necessary from the standpoint of a soil conservation program that size of unit be increased, a high percentage of rented land is owned by persons living outside of the county or State; this makes the problem more difficult because of lack of appreciation by the owner as to what constitutes the best long-time use of the land and the loss of resources from improper land use. Much may be accomplished in such areas by arranging with owners of contiguous land to round out units that might be placed on a more stable and permanent basis. This may be done by an operator's leasing of adjoining absentee-owned land.

Leases should be made for longer than the usual 1-year basis for the long-time land-use plan. A farm conservation plan is essentially a long-range plan. Benefits from crop rotation, pasture establishment, and proper use of range cannot be realized in a single year. If a tenure of at least 5 years could be assured, the tenant would realize the benefits from soil-conserving practices and would be more likely to put a farm conservation plan into effect. Greater security of tenure would give farm and ranch operators a longer planning perspective and would help greatly in stabilizing the application of such plans.

During the past 2 years the Southern Great Plains Region of the Service, in cooperation with the Farm Security Administration, has done considerable work in improving farm organization by increasing size of operating units. The units for reorganization have been selected jointly by these two agencies. The operator of the unit is ordinarily a Farm Security Administration client, selected because he has the

² W. P. A. Research Monograph XVI "Farming Hazards in the Drought Areas." By R. S. Kifer and H. L. Stewart, Bureau of Agricultural Economics.

necessary interest and ability for managing and operating the reorganized unit successfully.

Increase in size of unit was obtained in most instances through the leasing of additional land owned largely by absentee landlords. Where possible, leases for 5 years or longer were negotiated for the operator, and the Service assisted in drawing up a plan to utilize the resources of the enlarged unit. The Farm Security Administration lent money for purchase of breeding stock and other items necessary for operation of the farm and home.

Experience to date indicates gratifying results of the initial efforts in this direction. The average acreage of 125 reorganized units established before June 1, 1939, consisted of 285 acres of cultivated land, 220 acres of restoration land, and 1,813 acres of pasture. An average of 4.4 ownerships of lands have been consolidated into one operating unit as a result of this program. Many of these cooperators already have completed the soil and moisture conservation structures planned for construction over a 5-year period. Economic progress of these operators indicates that the majority of them will pay up their original loans before the end of the loan period. In other areas, the Farm Security Administration has been active in increasing size of operating units without the assistance of the Soil Conservation Service.

The tenant purchase activities of the Farm Security Administration can be used for setting up adequately sized units on some farms in many communities. Although a high proportion of indebtedness is involved, the greater degree of control by the operator over the land under his management has definite advantages over short-term crop-share leases. Ownership of an adequately sized unit with low interest rates gives the operator the long-time planning perspective necessary for best use of soil resources over a period of years.

In management of land acquired by public agencies, there is also opportunity to increase volume of business on farming units that are too small for minimum income expectancy. Allotments in community grazing associations, or the renting of blocks of this acquired land, can be made very effective in making small units more nearly adequate. Permits and allotments on national forest land and public domain can be granted in such a way that some progress can be made toward a minimum size of unit objective. In some areas, soil conservation districts can obtain control of abandoned homesteads and county or other public land to help in blocking up more desirable operating units.

The production credit facilities and the land bank

loans of the Farm Credit Administration can also be used in effectuating desirable changes in farm organization. The important thing is to have clearly in mind the economic potentialities for a specific combination of enterprises in a specific area. Plans should not be made that do not promise income sufficient to meet minimum living standards for the operator over a period of years. A conserving use of the land is essential if the income base is not to be destroyed. Effective farm planning involves the balancing of a proper intensity per acre with a sufficiently extensive area to provide income situations that can be projected with some assurance into the future.

Enlarging the size of farming units should not be looked upon as a separate part of the planning program but should be an integral part of it. In many instances it should be a definite part of the work in soil conservation districts and be given prominent consideration in the district program and work plan. Except for a limited number of reorganized units outside organized districts to serve as effective extension demonstrations, the most efficient use of the time of planning technicians of the Soil Conservation Service will probably mean the restriction of this activity to areas included in districts. The availability of machinery, and in some cases C. C. C. labor, as well as the need for follow-up in the application of farm plans, is another reason for considering the advisability of confining emphasis on unit reorganization by the Service to soil conservation districts.

In some areas a general increase in the size of farms means no decrease in the number of operating units. Many farms may have been abandoned following a succession of crop failures so that an increase in size of existing operating units would mean bringing idle or abandoned land into a conserving and productive use. This would make possible a less intensive use of land in the existing operating units without decreasing current income possibilities. The presence of large numbers of idle or abandoned units in the Great Plains suggests that the need of and the opportunity for enlarging farm boundaries is perhaps greatest in the Northern and Southern Great Plains Regions.

The need for increasing size of farms in connection with a more extensive use of land is found in many areas where the ratio of farm population to land resources is even narrower than in the Great Plains. In these circumstances the difficulty is often expressed by the query, "What are you going to do with the people?" In such instances, long-time objectives often must be compromised with immediate possibilities

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WATER CONSERVATION IN AN IRRIGATION SYSTEM

By EUGENE C. BUIE¹

SEEPAGE loss in the distribution system of the Buckeye Lateral Ditch Association was 45 percent of the total water received in 1937. This association obtains its water from an irrigation company. Such an enormous percolation loss was a serious matter to the farmers constituting the membership. Not only did these farmers pay for water which they did not get but their crops suffered from a shortage of needed moisture. To find a solution for this problem, they asked assistance from a Soil Conservation Service C. C. C. camp located near Wellington, Colo.

The main distribution ditches generally were located on section or half-section lines without regard to grade. As a result, the fall often was from 50 to 60 feet per mile. The sandy loam and sandy clay loam soils of this locality will not stand the resulting high velocity. The ditches eroded rapidly and eventually cut into soil strata composed of porous gravelly material. Seepage losses increased until, as stated, they reached 45 percent of the total water turned into the system.

Control was to be obtained only through the relocation of the ditches or through raising the bottom of ditches out of the porous strata. It was found more economical and practical to raise the ditch bottoms

by means of rock masonry drops than to construct new ditches. The masonry drops not only raised the ditch bottoms but also provided a permanently stabilized grade. Twenty-four such structures were built in 2½ miles of the Buckeye lateral ditch. It is anticipated that the remaining 9½ miles soon will be stabilized in a similar manner. The banks of exceptionally deep sections of ditch were often plowed in to expedite the sealing of porous strata and also to provide a more desirable cross section.

The assistance of the C. C. C. camp was by no means limited to the main distribution systems. Individual farm irrigation systems were revamped to provide better distribution and more economical utilization of water. Changes in each farm irrigation system were based on careful study of soils, slopes, topography, and adapted land use. Shallow soils and slopes too steep for efficient irrigation usually were either retired from cultivation or devoted to dry-land crops. The field ditch system was then arranged to provide the most efficient distribution and use of the available water on that part of the farm where it would be most productive.

New permanent field ditches were protected by weir drops. Badly eroded field ditches ordinarily were abandoned, plowed in, and replaced by new stabilized ditches constructed parallel to them. Temporary

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Typical condition of main distribution irrigation ditches prior to installation of stabilization structures.



Relocated, stabilized field ditch. Depression on the right is location of old ditch which was too deep to stabilize economically.

field ditches were laid out on established grades, their spacing regulated by the most efficient length of run for soil type and slope. The use of ditch lines as crop boundaries proved very satisfactory. By careful planning, it was often possible to use waste water for the irrigation of windbreaks.

It is difficult to evaluate accurately the benefit of this work to the community. William O. Evans, secretary of the association, stated that seepage losses already have been reduced to approximately 14 percent by the stabilization of only these $2\frac{1}{2}$ miles of the main ditch. This means that during the 1939 irrigation season 31 percent more water of the total amount delivered was available to the farmers than would have been otherwise. This is a saving, according to Mr. Evans, of 672 acre-feet, or \$1,629, to members of this ditch association, based on a 28-year average of appropriations and assessments. In terms of 50 shares per farm unit, each farmer realized a saving of \$110.83 in the water delivered to his farm.

Additional savings accrued where the farm irrigation system had been revised.

E. F. Munroe, president of the irrigation company, says, "This system has proved very effective. It has decreased ditch erosion to a minimum and made it possible to use all of the available water on crops, undoubtedly causing a decided increase in crop yields."

Mr. Evans, association secretary, speaks as follows: "Stabilizing ditches on my farm has helped reduce water loss and made irrigation of crops easier. I believe crop yields will be increased, but as yet I have not compiled any data to show results."

Fred Krumdick estimates that water supply on his farm was increased 25 percent and his crop yields 15 percent. Charles M. Holtcamp declares that his ef-

fective water supply was increased at least 5 percent by his farm distribution system and that his crop yields were increased 20 percent as a result of the work done by the camp.

The results clearly indicate the practicality of conserving irrigation water. Planned conservation, distribution and use of irrigation water in accordance with the principles of good land use and erosion control have not only proved valuable to irrigation farmers but have also broadened the constructive program of the Soil Conservation Service.

Approximately 1,000 water-facility projects are now under way in the 17 Western States. When completed these facilities will benefit about 1,700 families, make available for irrigation more than 50,000 additional acres, and place under conservation farming practices over 1,141,000 acres.

The Soil Conservation Service has announced that 8,500,000 acres of land in 141 land utilization projects established since 1933 will be opened for free public use for hunting, fishing, and trapping. All recreational facilities will be governed by existing State and Federal laws with regard to hunting, fishing, and trapping.

SOIL CONSERVATION IN SCHOOLS

The October issue of SOIL CONSERVATION will report classroom activities and educational projects pertaining to soil conservation.

THE POTATO PLANTER ADAPTED FOR SEED-SPOTTING FOREST TREES

By H. D. PETHERAM¹

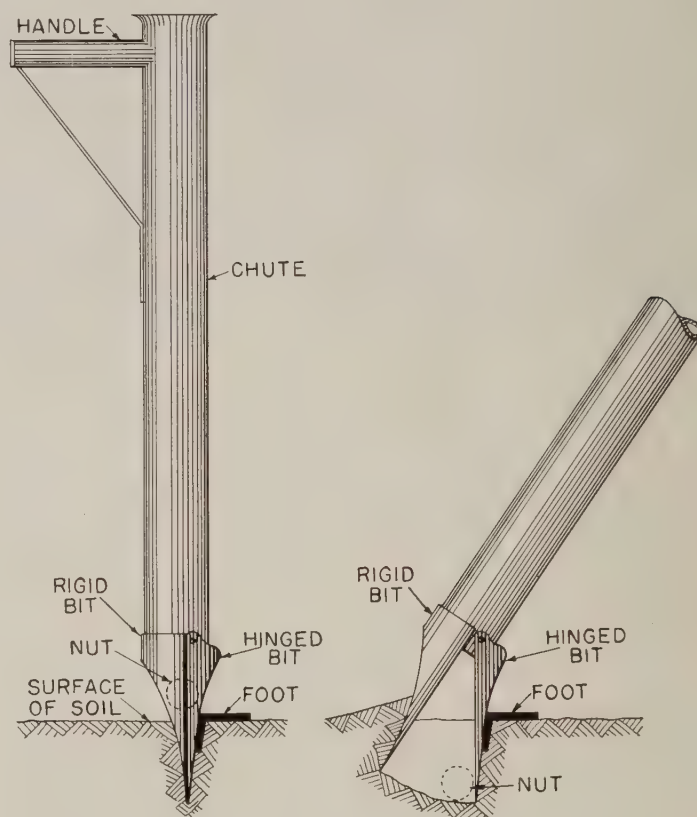
TO REMEDY depth variation in seed-spotting walnut, hickory and similar species, the old-fashioned hand potato planter was used very advantageously in 1934 and 1935 during C. C. C. camp operations under the United States Forest Service in Cherokee County, Kans. The plantings were made on waste land that was the result of coal mining by the stripping method.

Planting operations were begun by the shovel method, employing a three-man crew composed of two shovelmens and one dropper. The shovelmens, each equipped with a long-handled round-pointed shovel, removed one shovelful of soil from the spot where the nut was to be planted. The dropper was equipped with a bag containing a supply of nuts suspended from his shoulder. Stationed midway between the two shoveler, his function was to drop a nut in the hole made by each shoveler. The shoveler then replaced the soil and packed it by stepping on it in passing to the next spot. Depth of planting by this method varied from 1 to 6 inches and close supervision could not eliminate this variation because the shovelmens had no gauge for depth. It was apparent that a more accurate method was needed and thus the hand potato planter was introduced into the seed-spotting operations in the fall of 1934.

The potato planter should not be confused with the hand corn planter. The main part of the implement is a chute which might be made of a piece of eave conductor pipe about 3 inches in diameter and 2½ feet long. A handle is attached and braced to the upper end. On the lower end are two bits, one rigid and the other hinged. To the hinged bit is attached a foot that can be adjusted to any desired depth of planting. A step is also attached to the lower end of the chute for forcing the bits into the soil. (Planters of this type are available at wholesale dealers.)

The operator is also equipped with a canvas bag suspended from the shoulder by a strap. This bag will hold enough walnuts for one hour's planting.

The planter, when in operation, is controlled and carried by the handle. With the planter in a vertical position and the hinged bit to the front, the bits are forced into the soil until the foot on the hinged bit



rests upon the surface of the soil. At any time during this operation a nut is dropped down the chute and lodged between the bits. The planter is then pushed forward, forcing the rigid bit backward while the hinged bit is held in place by the adjustable foot. This opens the hole and allows the nut to drop. While the planter is still in this position it is lifted out of the hole, premitting the loosened soil to fall back upon the nut. The operator then steps on the loose soil to pack it. After a little practice he will find that all operations are easy and natural, with continuous movement forward and all back bending eliminated.

The potato planter method has two distinct advantages over the shovel method. In the first place, a uniform depth is obtained by adjusting the foot to the desired depth. A test of depth of planting showed that a 2- or 3-inch covering is most successful; shallower planting apparently results in an uneven supply of moisture while with deeper planting only the most vigorous seedlings are able to reach the surface. It is probable that this depth will vary with different soil types, the sandier soils requiring deeper planting.

The second advantage is that cost of planting is reduced. Actual test showed that one man equipped

¹ Regional division of forestry, Southern Great Plains Region, Soil Conservation Service, Amarillo, Tex.

with a potato planter can plant more nuts than the three-man crew using shovels. The "stop-and-go" system is replaced by continuous and natural forward movement, there is less weight of equipment, and all the work is coordinated in a single operator.

SIZE OF FARM

(Continued from p. 73)

and expediency. However, governmental subsidies in the form of work relief and benefit payments and other distress signals such as unpaid taxes and debts overdue, oftentimes may be due not only to an unfavorable price situation but also to the fact that farms may have been organized on a temporary and unstable basis. The effect of some forms of subsidy is merely to perpetuate the need for subsidy. Other kinds of aid to farmers, of a type to enable them to obtain more desirable land use and improve the productive capacity of the land through the establishment of improved practices, may answer not only current financial needs but help to bring about more desirable long-time farm organization. Every effort should be made to increase the proportion of the latter and decrease the proportion of the former kind of assistance to farmers.

Where the present organization of farms cannot be continued without considerable subsidy or acute distress and subminimum standards of living, the most important factors causing such a situation should be given greatest consideration. If an increase in the size of unit is more important than, or necessary to bring about, changes in cropping practices that promise to maintain resources and long-time production, it is of little avail to make the lesser plans which are almost sure to fail because of lack of consideration of more important items.

Minimum income cannot be expressed as a dollar figure equally useful in all areas because of the wide variation in alternative opportunities for employment between specific groups of farmers and between specific areas. Differences in living costs as affected by availability of fuel, the possibility of home gardens and variations in transportation costs, account for variations in the specific dollar figure even under a uniform definition of minimum income. Loosely defined differences in standard of living constitute another reason for variation in the somewhat arbitrary figures chosen in different areas. For the present purpose, minimum income for a specific locality may be defined as that which is adequate to meet minimum standards of

health, education, and individual and community well-being.

While the ramifications of the size of farm problem extend beyond the policy of the Soil Conservation Service into our general agricultural and industrial policies for the Nation as a whole, it is a problem that deserves recognition at all policy levels. This problem might be called one of unemployment or ineffective employment on farms closely related to industrial unemployment in cities. While the full solution of the small farm problem may not be found until some way is devised to utilize effectively our other labor resources, recognition of its incidence on soil conservation may be helpful in determining intermediate courses of action that will alleviate rather than aggravate undesirable situations.

JOHNSON GRASS

(Continued from p. 70)

On farms where Sudan is grown for seed there is some danger that it will become contaminated with Johnson grass if the two are grown in the same field. Otherwise, as previously explained, there is small chance of contamination. It is important, too, that the area under discussion furnishes only an insignificant part of the Sudan seed used throughout the Southern Great Plains. The successful growth and use of Johnson grass plantings depend upon the skill and efficiency of the individual operator in: (1) Seeding and growing of the grass, and (2) managing his livestock grazing enterprise so as to obtain the maximum economic returns consistent with safe use of the land and wind-erosion control.

While Johnson grass is not a cure-all for the grazing problems of this area, it does have the advantage over Sudan and other sorghums in that, once started, it will spring from the rootstocks every year regardless of the fact that much soil has drifted or lodged on the field. Drifting soil will not kill out young root-sprung grass. If there is sufficient moisture in the ground, the grass will come up through 6 to 24 inches and furnish a good binder to hold the soil. On the whole, it would seem that in limited areas in this region Johnson grass may furnish the answer to the quest for a plant that is relatively easy to grow and maintain, that will hold the soil well and will furnish satisfactory annual economic returns.

Controlled studies of the growth habits and other factors peculiar to Johnson grass are now under way.



The Making of "A Heritage We Guard"

By WILLIAM R. VAN DERSAL¹

SIXTEEN months ago we began work on a new Soil Conservation Service motion picture about wildlife and soil. It is soon to be released under the title "A Heritage We Guard."² Between the time



One of the gulls that open the picture.

the scenario was started and the day the final touches were given the completed film is a story to confound anyone who thinks that movie-making is a simple matter.

I thought that once, myself, but not any more. I've learned from experience that a good motion

picture like any other creation is about 1 percent idea and 99 percent hard work.

The labor that went into the making of "A Heritage We Guard" began with the preparation of a scenario. The writing went slowly at first, ideas at this stage being nebulous and disconnected. The first scenario did not take long to complete; perhaps that is why it had to be discarded. The second was written with an entirely different approach, but it too was unsatisfactory. Finally emerged a third scenario which told a simple story of American land as people found it, as they used it, and as they must manage it if it is to be preserved. The final title, "A Heritage We Guard" conveys pretty well the underlying theme.

¹ Biologist, biology division, Soil Conservation Service, Washington, D. C.

² The director and editor of the new film is Maurice H. Joyce, formerly of the division of information, Soil Conservation Service, and now a director of training films with the U. S. Army; the principal cameraman is Rodney Radford, regional photographer, Pacific Southwest Region, Soil Conservation Service, Berkeley, Calif. Subject matter, direction, and writing were supplied by the author of this article.



A herd of sheep mills past the chuckwagon on a Utah range. The movie camera is out of sight below the hill in the foreground.



Sunlight is reflected on the face of a woodchopper with a silvered plyboard.

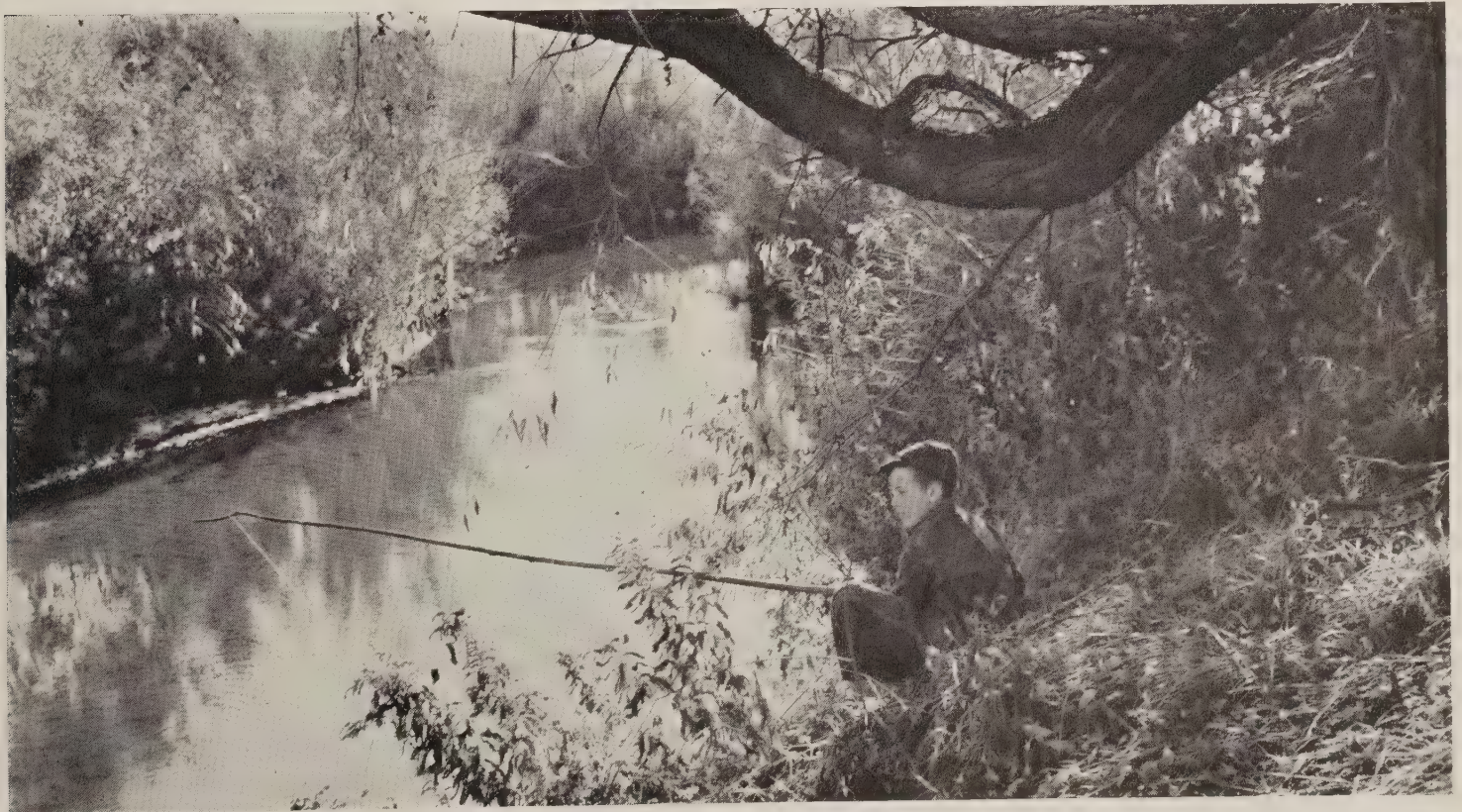
From the scenario was assembled a shooting sequence which grouped together the scenes to be made in any one locale. All the supplies were assembled—film, cameras (more than one because many scenes must be shot from several angles simultaneously), batteries to supply power for the motor-driven camera, reflectors to get sunlight into heavy shadows, lights for interior work, long and short tripods, and a host of other miscellaneous materials required for a picture-making field trip. On a soggy day in September, the company finally set forth.

Now that the necessary thousands of feet of film are “in the can,” the camera break-downs, the bad weather, the shipment troubles, the failing light, the delays, the uncertain human and animal subjects, all the other things that can—and always do—go wrong during the filming of a picture, seem unimportant. But at the time they took the “glamour” out of movie-making, just as the director knew and said they would.

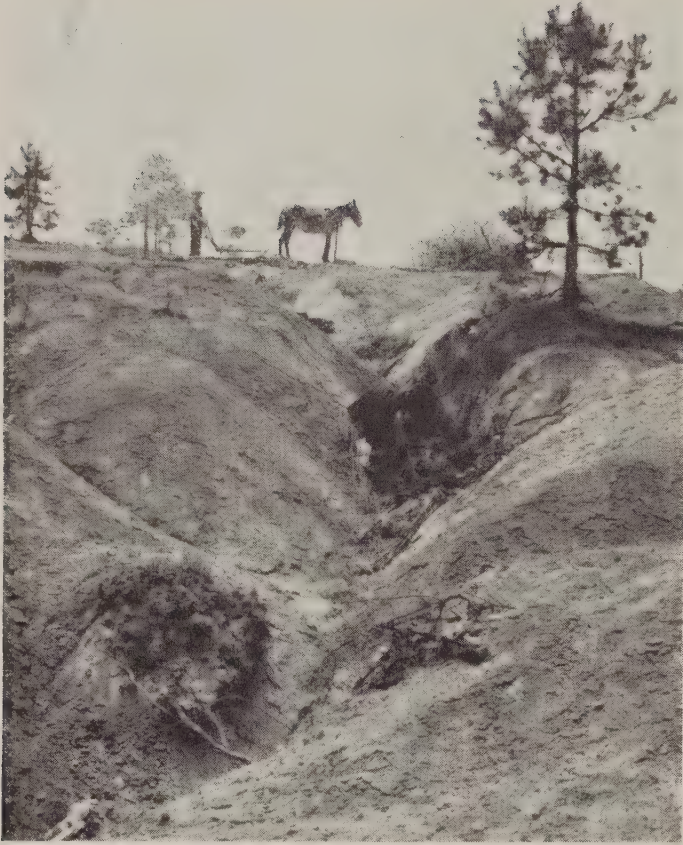
The Wilderness Material

“A Heritage We Guard” opens with scenes of the country as it looked when settlement first began. Anyone at all familiar with present-day conditions knows that photographing original forest in the eastern United States is now almost impossible since most of it is gone. For “long shots” with panoramas showing a vast extent of forested country, the best that could be done was to show scenes in North and South Carolina made from a vantage point looking toward the Great Smokies. All the rolling hills had long since been lumbered over, but from a distance this is not apparent now. Close shots of forest interior were more difficult; small bits of forest known to have been undisturbed had to be located and the shots made there and nowhere else. Such places are usually remote, as the company soon found.

Areas of virgin grassland—large quantities of it—are nearly as rare as original eastern forest. However, in northeastern Nebraska near the proposed Grassland



Wallace Moilien fished in clear Coon Creek, now fully protected by willows planted six years ago by the Service.



Still plowing while gullies eat farther and farther into his field, this farmer posed for the camera on the skyline.

Monument, there is a piece of prairie that is relatively, but not entirely, undisturbed where there were not so many fence posts and telegraph poles but that the camera could get a sweeping panoramic view without including these ubiquitous signs of civilization. The great herds of buffalo and antelope that were once so much a part of the plains region are now gone. The photography had to be done on Federal or State game refuges. The picture shows the best that could be found, but the numbers are woefully short, even though the effect of special camera angles is to augment the impression received by the audience. Buffalo, by the way, are by no means easy to direct, and there was one time when the future of the Service personnel involved was, to say the least, uncertain.

Other wilderness denizens presented special problems; some were impossible to "shoot." Passenger pigeons have been exterminated; there could be no picture of them. California grizzlies are extinct too, but the Kodiak grizzlies can be distinguished only by an expert mammalogist; so Kodiak bears were used instead, from the film library of the Biological Survey. Waterfowl are now decimated, but even so, great numbers still concentrate on refuges where they can be photographed. Most Indian scenes came from Hollywood studios. One Indian was filmed by Service

cameramen near Pendleton, Oreg., for a special scene. For \$2.50 this particular redskin agreed to remove his mustache, which seems to be some sort of commentary on modern civilization. It also sets, perhaps for the first time, a standard price for mustache-removal.

Early Days

Photographing historical scenes is not so simple as Hollywood makes it seem in the spectacular pageants that show almost weekly at the local theaters. Scenes historically correct require extensive research. As they were taken for "A Heritage We Guard," the scenes of early settlement were obtained in remote rural districts where dress and ways of doing things have not developed much beyond pioneer days. It is still possible to find houses just as they were made in earliest times, occupied by people whose lives follow a pattern much like that of early settlers. Wild game supplies a part of their food, just as it did when the country was new. Their plows are simple hand-wrought pieces of iron with a small sapling for a handle. Oxen, yoke and all, pull the crude implement in rough, partially cleared land. By paying attention to details such as "store haircuts," or anything else that is "new," the pioneer days can be reproduced in numbers of places in this country.

Portrayal of early days in the plains was not so simple. Covered wagons are still used, but they are not easy to locate, and when found they usually need repair. Early types of steam trains called for by the scenario, if they have not long since rusted to pieces are to be found now mostly in museums. In such dilemmas the Hollywood studios helped enormously by providing sufficient material from their libraries.

Early cattle of the true long-horned type have been replaced by superior breeds. But the scenario called for longhorns, and fortunately there is one small herd left, laboriously assembled some years ago by the Forest Service and now preserved on the Wichita Refuge in Oklahoma. These animals are a real curiosity, exciting as much interest at the refuge as buffalo or antelope. And in Oklahoma the historically accurate longhorns milled about obligingly while the cameras recorded them from all angles.

Sheep and examples of overgrazed range were shot in the Southwest with the help of amiable and mildly interested sheepherders. A flock of several thousand, complete with herders, dogs, and chuckwagon provided material for many fine scenes. After the almost incredible numbers of sheep had passed by, a few shots to show the condition of the overstocked range provided an all-too-clear illustration of land abuse.



Longhorn cattle on the Wichita Refuge in Oklahoma.

Good localities for photographing erosion and its effects were not difficult to find. There was little need to put them in the shooting schedule. Erosion was filmed as opportunity, i. e., good light and time, permitted, because eroded land was revealed almost at every turn in the road. The biggest problem was to avoid shooting too much, thereby seeming to emphasize the severity of the erosion problem—if, indeed, that can really be done. Certain it is that the finished motion picture did not need to dwell on any one part of the country. There was plenty of material from every section and it included everything from gaping gullies filled with the inevitable automobile parts to worn-out fields and wretched and dilapidated farm buildings on land long since in the submarginal class.

Rain and washing soil were photographed down South one rainy day. Beginning with black clouds and running through spattering raindrops on bare soil to rivulets of muddy water, and finally to swollen, muddy streams, the scenes tell quickly and simply the now-familiar story of wasteful farming.

Abundant wildlife is an accompaniment of sound land use. Like soil, wildlife depends for its survival on good cover. Unlike soil, however, animals are photographically extremely interesting, and they enliven many scenes in which it would otherwise be difficult to hold or awaken interest.

In "A Heritage We Guard" wildlife is shown to be a part of the heritage, and numerous close-ups of birds and mammals are used. Fortunately for the Service, Dr. Arthur A. Allen, of Cornell University, nationally famous for his bird films, had on hand a large amount of film and sound of farm birds. His pictures have been made at considerable expense and over many years. From his library much excellent material was found to be adaptable.

The wild mammals—squirrels, raccoons, foxes, rabbits—were more difficult. They are extremely fearful of man and consequently hard to film. The Service photographer was lucky with a few animals. While

shooting the long-horned cattle, for instance, he managed some very good opportunity shots of a rabbit. Some close-ups had to be made at the Washington Zoo, to the profound discomfiture of the camera crew as well as the animals. Strong lights were necessary, and strong lights are notorious for driving animals into hiding.

It has been said truly that a picture is made in the cutting room, and so it was with "A Heritage We Guard." All the scenes were at last assembled, the obviously poor ones discarded, the several takes of each scene examined for the best, and the selected material spliced to make the first cut. In spite of the greatest care in the field, some scenes did not match those with which they were cut, and there was much shifting and fitting and paring until the continuity was achieved. Dissolves, fades, wipes, montages, superimposes—the simple tricks of making a film easier to follow were calculated and manufactured in the laboratory. Once in final shape the proper music was put on its sound track, the special sound effects on another sound track, the commentation added—three sound tracks synchronized with the scenes, every sound matching action on the screen.



The cameraman and director shoot a panorama of "virgin" forest in the Carolina hills.

KIKUYU GRASS



Kikuyu controlling a once-acute gully on the W. A. Hardison farm, Las Posas project.

KIKUYU (*Pennisetum clandestinum*)—a grass which was once considered objectionable in California because of its resistance to control and eradication—is now being requested for use in erosion-control activities by many farmers in the Pacific Southwest Region.

Kikuyu is a native of Uganda, Africa. It is now widely distributed throughout New Zealand, Australia, and South Africa.

Kikuyu was introduced into the United States by the United States Department of Agriculture in 1915, and was first tested at various sites in California in 1916. Because it was thought to be difficult to control and eradicate, plantings of the grass were restricted for observational purposes. These observational plantings have shown Kikuyu to be well adapted to southern California conditions. It has successfully withstood temperatures as low as 23° F.

Kikuyu is a strong, creeping perennial grass. The grass forms a dense turf, with branching leafy stems; its leaves are flat and spreading. In areas of limited rainfall, it will make little top growth, although it sends out shoots and spreads along the ground, establishing itself firmly. In the presence of moisture, however, it has been known to grow as high as 2½ to 3 feet. It grows well on moist soils, and it responds vigorously on good soils. It has not been known to yield seed in California and can be established only by roots or runners. It is very aggressive and resists other plants growing with it. Weed invasion, therefore, is avoided. The initial

cost of establishing Kikuyu is slightly higher than that of seed-bearing grasses, but this is compensated for by the fact that once it is established, it will take care of itself and needs no replanting.

Kikuyu is essentially a pasture grass. As a forage crop, it is known to be as luscious, palatable, and nutritious as Bermuda.

Kikuyu has great possibilities as a soil binder for dam embankments, eroding slopes and gullies, and for revegetation purposes. Some excellent grassed waterways, on which Kikuyu is used, have been developed in California; some of them are on very steep slopes. A farmer in South Africa has completely reclaimed a gully on his farm with Kikuyu. The gully, cutting across his land 15 feet deep in some places, was draining the soil of all its scanty moisture (the rainfall in the area is approximately 10 inches). He began his experiment of gully reclamation with Kikuyu in 1922. Today, the gully is entirely healed and is furnishing a pasture of unexcelled quality. A detailed discussion of this experiment appeared in the February 1940 issue of "Farming in South Africa."

If it is desired to control or eradicate the grass, this can be done by plowing and subsequent cultivation to expose the underground parts of the plants to the sun or frost. A visitor from Australia recently remarked that he was surprised that California farmers are afraid of the grass, because it is one of the best species grown in Australia and very little trouble is required to control it.—Lenora E. Eastwood.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neill Faris

THE PLOUGH-UP POLICY AND LEY FARMING. By Sir George Stapledon. London, 1939.

This is a down-to-earth book, urgent and at the same time eminently practical. Over a year ago Great Britain offered to pay her farmers to plow the "green swards" of Old England and start an intensive emergency program to improve fertility of the soils. It was fortunate for British farmers that Dr. Stapledon was in a position to produce so quickly this book on the new policy; otherwise the program might not have gone forward with such speed to meet so effectively the present food-crop and livestock-forage emergency. The volume is reviewed here to point out the details of Britain's plan to conserve her stale and derelict grasslands by a rotation farming scheme that may well be adaptable to many parts of the United States. Certainly, we have already learned much from England and Wales about maintaining fertility, and now Dr. Stapledon causes us to think deeply about grassland management and soil fertility in connection with our own program to extend our grass acreage. Sir George Stapledon has world-wide recognition for his work as director of the Welsh Plant Breeding Station, the Cahn Hill Improvement Scheme, and the Imperial Bureau of Pastures and Forage Crops, Aberystwyth, Wales. According to the latest issue (June 1940) of *Herbage Reviews*, he is also to be in charge of the new project to establish demonstrations on 600 acres of poor-condition heavy clay land near Stratford-on-Avon to show details and effectiveness of (1) improvement as permanent grass by various methods short of plowing, (2) farming by rotating temporary grass with arable crops and, (3) plowing and immediate reseeding.

Fertility is not produced merely by plowing in the sod—this is emphasized. A poor sward is a pasture deficient in phosphates and nitrogen, a pasture with an impoverished or pot-bound sod with the wrong assemblage of grasses and plants—this is pointed out so simply and with such downrightness that no farmer can mistake his poor pasture for a good pasture. Directions for plowing, applying fertilizers to rot down the old sod, for planting and handling catch crops, for grazing without waste of forage and for proper manuring, and for harvesting throughout rotations are so definite and authoritative that they can be used, and no doubt are, by British farmers as field rules to be followed to the letter.

In view of the emergency in Britain, Dr. Stapledon offers grassland farmers two alternatives, and before choosing they must first know the soils underneath their sod and the sward topping the soils. Are they the better soils or the poorer? Are the swards derelict or good or merely fair? Farmers of Britain are told how to deal with any and every British pasture—how to plow to kill old turf in preparing for an autumn cereal or spring crop or a mixture on better soils; how to manure the poorest pastures by intensive grazing before plowing and preparing tilth for a pioneer crop; how to turn permanent pastures into cropland for a 10-year emergency period.

Throughout, several points—they cannot be called theories because Dr. Stapledon does not theorize—several points stand out as particularly pertinent to the United States grassland programs. The first is, of course, the fact that the poorest soils are being

restored quickly by means of frequent plowing and cropping combined with heavy grazing of the "on-and-off" type for the specific purpose of complete plant nutrient turnover. Second, the indigenous varieties and strains of grasses and clovers used in grassland rotation farming in England and Wales are interesting from the point of view of needs for hay and grazing needs. In England and Wales, most experiments have dealt chiefly with pasture strains and farmers have been disappointed in first- and second-year hay crops from the pasture plants. Dr. Stapledon attempts to meet this difficulty with a plan to include pasture strains in small amounts for 3 years in order to produce more leafy hay, increase both pasture and hay yields, and to provide a longer effective grazing season.

Many rotations are recommended, all of them based on trial and the author's broad experience and knowledge. One of them is particularly interesting in that it is designed to restore the poorest soil quickly with use of artificial fertilizers. Briefly, it consists of (1) ribgrass, (2) hardy green turnips and Yorkshire fog, (3) hardy green turnips and Italian ryegrass, (4) hardy green turnips, rape and Italian ryegrass, (5) rape and Italian ryegrass, (6) rape and Italian ryegrass with 1 pound of hardy green turnips. Such a rotation calls to mind some of the industry-devastated areas of the United States, or pastures grown to weeds that might be plowed up and prepared for potatoes, kale or seed mixtures for grazing.

One chapter suggesting that herbs may supply needed minerals to livestock is interesting especially from the point of view of research. Apparently little had been done along this line at the time Dr. Stapledon wrote "The Plough-up Policy and Ley Farming." It had been noticed, however, that stock turned on "super" swards tended to graze hard around edges of pastures and a group at Aberystwyth had started experimenting with strips of herbs sown with slow-maturing grass in leys. Results of these experiments will be most interesting when they are forthcoming.

Seed mixtures for catchcrops, for 12- to 18-month swards with catchcrops, for 2-, 3-, and 4-year and longer leys are set down with appropriate proportions per acre for all-grazing, all-hay, and grazing and hay pastures of different durations. Permanent pastures are not treated in detail, as the purpose of the book is to advocate plowing up of poor permanent pastures.

The chapter on grass and clover seed production is written by Mr. Gwilym Evans, one of Dr. Stapledon's associates in Aberystwyth. It turns out to be an exceedingly direct and well-organized account of methods used by farmers who grow seed for the Welsh Plant Breeding Station. Mr. Evans first points out climatic and soil conditions and situation required for best seed growing in England and Wales. Highlights of technique may be briefly outlined as follows: Green crops are generally the best preparatory crops for production of herbage plant seeds, although fertile land if manured will grow ryegrass and clover seed after two crops of corn. Grass and clover for seed should be isolated 200 to 400 yards from each other. Grasses may be broadcast or placed in drills; clovers may be broadcast in corn. Cultivation, manuring, weeding and grazing of seed-producing pasture plants constitute an intensive type of farming requiring constant care and labor and observation, nor does vigilance decrease in judging ripeness, harvesting and drying the seed. After ryegrass seed crops broadcast with



BOOK REVIEWS AND ABSTRACTS

continued

white clover, corn may be grown. Straw of seed crops is used for fodder.

It must be remembered that Dr. Stapledon writes of the pastures of Britain; but, even so, grassland rotations are none the less important in our own regrassing program for soil conservation and fertility. In the book reviewed here the chapter on management of the ley is peculiarly important in that it points out urgently what not to do, what to do and how, for lush sward, for soil fertility and for a type of rotation that is safe, practical and productive of high quality crops in England and Wales.

While I was talking over Dr. Stapledon's book with C. R. Enlow, chief of the Division of Agronomy of the Soil Conservation Service, Mr. Enlow made the following remarks clarifying differences between Britain's plow-up policy and America's more-grass policy:

"Dr. Stapledon presents a philosophy that is essential in a grassland agriculture, a type of farming that is being promoted at the present time in this country. The importance of bringing sod crops into the rotation for the improvement of our soils cannot be overstressed. But it must be understood that to get an increase in organic matter and improvement in soil structure we must use desirable grasses and legumes and not worthless ones. To do this, we must expect to apply minerals in sufficient quantity to overcome soil deficiencies and encourage the growth of desirable sod crops; and we must manage properly the sod crops as hay or pasture to secure profitable returns plus soil improvement.

"In the program for soil conservation in the United States, a very large acreage of infertile cropland is being retired to so-called 'permanent' pasture and meadow. This land should give us great concern as we cannot expect it to produce good pasture or hay if it will not produce good crops. Without soil-building practices, we may be overstating in declaring it safe from erosion.

"We already have many millions of acres of 'permanent' pasture that are practically worthless in their present condition because of soil impoverishment, overstocking, or both; and the land is actually deteriorating. Bringing sod crops into the rotation with cultivated crops for hay and grazing would tend to relieve this land and also would improve the cropland.

"To the traveler in England, it appears that the entire countryside is in grass, while the reverse is true in the United States. We need more grass at the moment, England needs less. The ultimate objective, permanent agriculture, is the same."

Britain's emergency fertility program is requiring plowing and more plowing, and it may be unfortunate for our own grassland program if we do not plow enough. In this connection the following statement made by Dr. P. V. Cardon, an authority on pasture in the United States, is quoted from O. E. Baker's review of "The Plough-up Policy and Ley Farming" which appeared in the April 1940 issue of the *Geographical Review*:

"Two things, implied in the title, are significant: First, the 'plough-up policy' is, in a sense, a reversal of policy. Britain is a grass country, and, traditionally, we Americans think of Britain as a good example of what countries wedded to the grass-land philosophy may accomplish. Yet, despite her earlier trend, Britain today is plowing up grass, paying farmers to do it, under a national policy not born of, though accelerated by, war. The primary purpose of the 'plough-up policy' is to conserve soil fertility. This strikes me as significant. Whereas we in America are urging grass

planting as a means of soil conservation, Britain now turns to grass breaking for the same purpose.

"This is not difficult to understand, if one is aware of the second point I would stress as coming out of Dr. Stapledon's book, namely that grassland itself grows stale. The solution is 'ley farming.' We call it 'rotation farming.' This is important. I have long felt that merely to extend our grass acreage will fall short of solving our more basic problem, soil conservation. We must find the place of grass in farm practice and utilize grass with other crops, in a general scheme of rotation or ley farming. * * * The pattern, as I see it, is grassland agriculture, conceived on a rotation basis—a rotation of crops, including grass, where crop rotation is feasible, and rotation grazing of a high type on our range lands."

REVIEW AND DISCUSSION OF LITERATURE PERTINENT TO CROP ROTATIONS FOR ERODIBLE SOILS. By C. R. Enlow. U. S. Government Printing Office, Washington, D. C. Manuscript completed July 1939, published June 1940.

This new bulletin points out the serious dearth of published material having to do with suitable crop rotations for tremendous areas in the United States that are subject to wind and water erosion. The urgent need for experimental work, more planning, and better coordination of rotation methods and sequences for the purpose of fertility increase cannot be ignored for long if the organic matter content of the soils of many areas is to be maintained. Judging from Mr. Enlow's review of the available literature on the subject, most rotations used in the United States have been designed specifically to increase yield and income, and many have failed to maintain and improve fertility conditions. He emphasizes the fact that it is very difficult to develop rotation sequences for many regions and areas of so large a country from a study of the available literature.

The discussion of the writings of upwards of two hundred authors shows that there has been considerable confusion of objective in the attempt to establish cropping practices that will meet production requirements and at the same time improve soil conditions and control erosion. Such confusion is clarified greatly by this type of study.

The review of the available material is based on known soil organic-matter losses for various parts of the country and rotations that have been tried out in attempts to determine the places of soil-improving crops in different rotation sequences. Findings at soil and water conservation experiment stations and Federal and State experiment stations are arranged regionally to point out the wide variations of cropping required for the soils of the great soil groups as distributed throughout the United States.

A complete bibliography of the authors and works reviewed is given at the end of the bulletin. This, with Mr. Enlow's discussions of the problems from the point of view of the agronomist whose duty it is to develop rotation programs for recommendation to farmers, should make this study of the literature of real value to agronomic planners and especially to experimental workers attempting to establish data to support crop rotation recommendations.

For REFERENCE

Compiled by **ETTA G. ROGERS**, Publications Unit



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LARGE HERDS OF CATTLE ROAM THE "THOUSAND HILLS"
OF THE WEST. THEY MUST HAVE WATER, GRASS. GRAZING
SHOULD BE ADJUSTED TO THE GROWTH REQUIREMENTS OF
THE PLANTS SO THAT THE RANGE WILL RE-SEED ITSELF.



OCTOBER 1940

*An Issue Featuring
The Educational Approach
to the
Soil Conservation Task*



SOIL CONSERVATION

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UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., 10 cents a copy, or by subscription at the rate of \$1.00 per year, domestic; \$1.50 per year, foreign. Postage stamps will not be accepted in payment.



During the past 2 years the Educational Service of the State Department of Conservation has made available to Tennessee schools 103,000 seedlings for use in connection with conservation problems. (Photograph by courtesy of Tennessee Department of Conservation.)

EDITOR'S NOTE.—Soil conservation is a subject of widespread interest to students and teachers alike. This issue of the magazine offers a small selection from many available reports. It makes no pretense at complete coverage or adequate representation.



A representative of the Educational Service of the Tennessee Department of Conservation discusses with fifth-grade boys and girls the effect of uncontrolled run-off on agricultural land unprotected by winter cover crops. (Photograph by courtesy of Tennessee Department of Conservation.)

SOIL CONSERVATION



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CONSERVATION AND THE CLASSROOM

AN INTRODUCTION TO THIS ISSUE

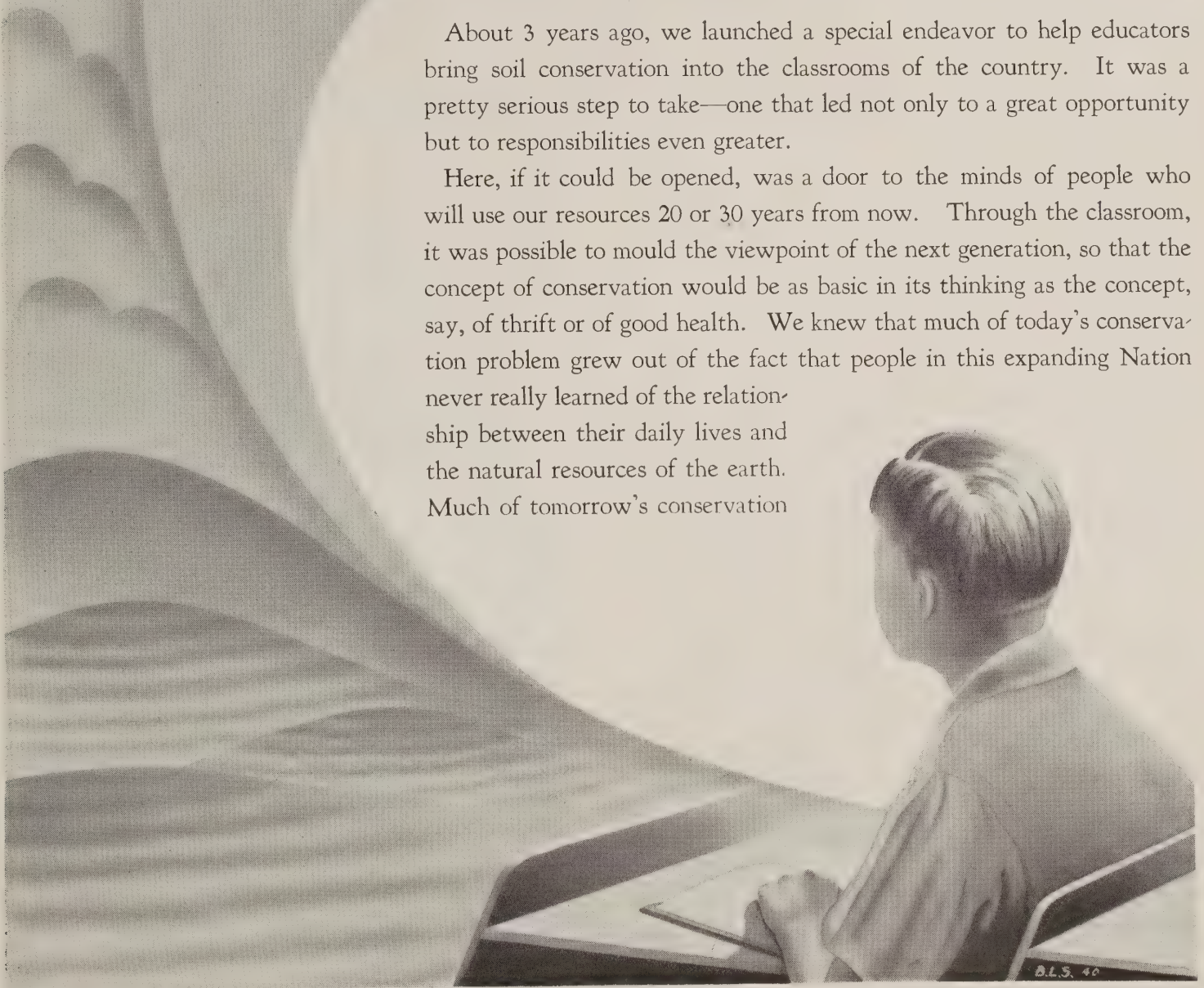
by

George A. Barnes

Chief, Division of Information, Soil Conservation Service

About 3 years ago, we launched a special endeavor to help educators bring soil conservation into the classrooms of the country. It was a pretty serious step to take—one that led not only to a great opportunity but to responsibilities even greater.

Here, if it could be opened, was a door to the minds of people who will use our resources 20 or 30 years from now. Through the classroom, it was possible to mould the viewpoint of the next generation, so that the concept of conservation would be as basic in its thinking as the concept, say, of thrift or of good health. We knew that much of today's conservation problem grew out of the fact that people in this expanding Nation never really learned of the relationship between their daily lives and the natural resources of the earth. Much of tomorrow's conservation



problem might be solved, we felt, if the people of tomorrow could be taught that relationship as a part of their basic education.

But if we saw opportunity in the schools, we also saw the grave responsibility involved. An approach to the classroom, we realized, called for great integrity—for the most scrupulous adherence to fact, and the utmost care to avoid anything that might come within the current, noxious connotation of “propaganda.” If we were to feed material to the classroom, we felt, we must do so in the best tradition of the teacher and be as alert to misinformation and distorted fact as we were anxious to impart knowledge. We should fail in our responsibility, we clearly saw, if any hint of institutional promotion or indoctrination should enter into what we were doing.

I believe we have borne the responsibility. I know of no instance wherein our work with the schools could be criticised. If we have been at all successful—and I think we have been—it has been due in no small part, I feel sure, to this sense of duty and responsibility.

By and large, educators of the country have welcomed the assistance which the Service has proffered to them. We have provided them with the facts, and they have passed their information along to the children in connection with studies of science, agriculture, social problems, economics, and government. Many have displayed an understanding and enthusiasm that left nothing to be desired. Teachers, apparently, are anxious to teach conservation. They need help with subject matter—suggestions and advice of the kind the Service is in a peculiarly favorable position to give them—but they are becoming our allies in the conservation movement in constantly growing numbers. They will bring conservation to the classroom if we will only help. And of course we will.

In this issue we review some of the outstanding educational developments in which the Service has had some part. There are a great many others, all testifying that the coming generation will not be unaware of its dependence on the soil.

LAND USE AND THE MODERN SCHOOL

By JULIA B. TAPPAN¹

IT IS clear that the immediate problem of the Service lies with the adult population of today. But in a long-time program of soil conservation and land use, this problem becomes the concern of the future citizens of the Nation.

The youth of today faces a complex and difficult economic and social situation in which an understanding of land use is vital. A review of the history of changing education and its parallel to the changing organization of governmental agencies, with some of our methods of approach and our experiences, may serve to show what a great opportunity lies before the Soil Conservation Service and other agencies of the United States Department of Agriculture in relation to the citizens of tomorrow.

A school grows out of the society in which it is found. Early Americans expected their government to protect them against foreign invaders, to provide currency for the exchange of goods, and to meet similar indirect needs. Each family, or at least each community, was self-sustaining. The schools of the period likewise had a limited scope. In 1840, the average person spent only 1½ years in school. Students and teachers were concerned with reading, writing, arithmetic, moral precepts, and discipline—spare the rod

¹ Regional division of education-information, Southwest Region, Soil Conservation Service, Albuquerque, N. Mex.



One of our future citizens.

and spoil the child. Children had a functional part in family and community life, receiving much of their education through experience and work in the home and community.

By 1925 an agrarian society already had become complex, interdependent, industrialized, urban. And a small school of this period was expected to offer about 20 courses in rigidly divided fields of subject matter—courses which had been added to meet first one demand and then another.

It has been apparent for some time that education must be reorganized to meet the broad issues faced by this changing society. Today the new education is concerned with significant controversial problems of our society, such as depressions, unemployment, wars, armament, increased nervous and mental diseases.

The educator of today states that education must be "social engineering, * * * a continuing process of complete socialization." The pupils of more than one high school in different parts of the country, instead of studying subdivisions of traditional subject matter, now study their own centers of interest—the school, home living, the local community, the metropolitan community, conservation of cultural and material resources, our changing methods of production and distribution, governmental and other social agencies in cooperative living, work in relation to everyday living, health, social relationships, use of leisure, economic intelligence, intellectual living, vocation.

The old curriculum of numerous subjects, bulwarked by rigid courses-of-study, is being replaced by the new curriculum: "All the experiences the child has under guidance of the school." These experiences include both those in the controlled environment of the school and those in the community at large. This curriculum is built from two sources: From the social scene and from the characteristics (biological and psychological) of the child. This curriculum is always evolving. It is never the same in any two communities, or in any two classrooms in the same community, or in the same classroom during any 2 years.

To be sure, all this does not mean that teachers and children go ahead without objectives and without goals. There are certain fields of knowledge with which we must be familiar, certain attitudes and modes of behavior necessary for participating in human society. Schools are still places of learning, but true learning requires thinking and participation. In connection with this new curriculum, reading, writing, and arithmetic are as necessary today as they were yesterday.

A pupil learns, however, not by accumulating facts, dates, details, by passing examinations, by mastering the obvious and conforming to the conventional, but by following with the guidance of the teacher the four stages of a typical life experience—purposing, plan-

ning, executing, evaluating. "The living curriculum is one in which teachers and children together are facing situations, solving their problems, building broad understandings of social relationships, and establishing intelligent controls."²

Clearly, conservation and land use have a place in such a scheme of education. The problem is vital to city dwellers as well as to country dwellers, to the whole population as well as to land users. Every community has a direct or indirect land-use problem of its own which logically may be used as a vital starting point for pupils and teachers.

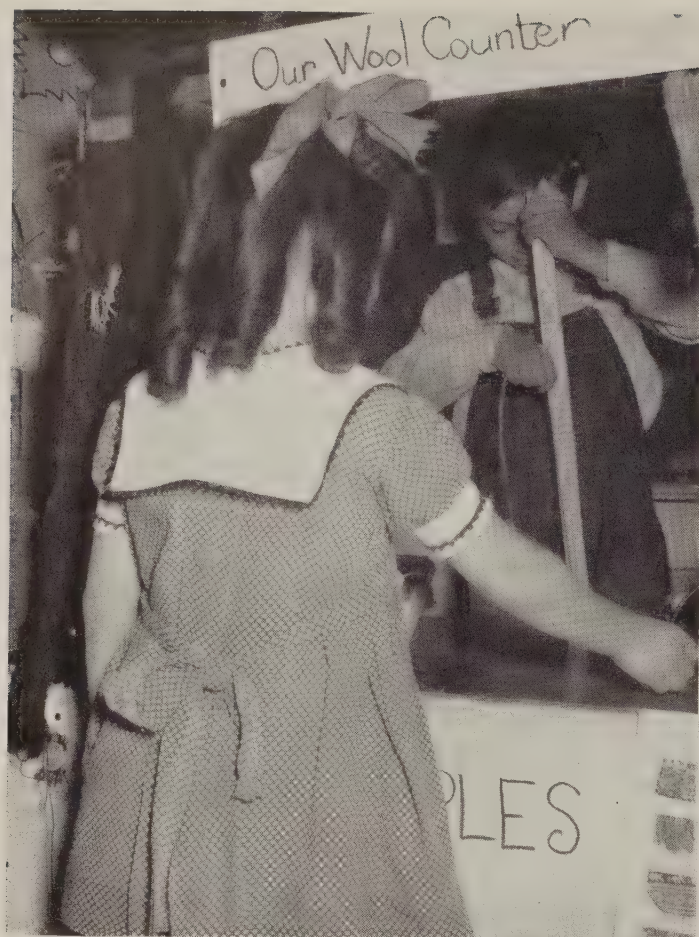
In initiating the program in the field we contacted school systems, teachers, and colleges. It became apparent to us and to the educators that, although natural resources and conservation had been included in courses, there was still much to be done in developing a conservation-minded population, and a population ready and willing to face necessary changes in land use. Certain schools were selected with the advice of the school authorities, and in these teachers and pupils were assisted in developing a meaningful conservation education.

We served as interpreters of the knowledge and the changing experiences of the technical staff of our Service. The teachers with their students were the developers of the curriculum. Just as the Soil Conservation Service began its program by establishing selected demonstration areas, so we selected demonstration areas of education. Just as our land demonstration areas were selected to include various methods and various types of problems, so our education demonstrations were selected to include various aged groups, various methods of teaching, and various geographic areas.

The experiment met with marked interest and led to immediate demands for help, for material, for an expanded program which we were not ready to give until our findings with children and teachers had a longer period of trial.

Certain general procedures and principles were evolved. The land was the textbook. Pupils and teachers used their own community and area. They walked on the land, observed it, learned to recognize the symptoms of misuse, to discover the causes, and to work out for themselves the principles of good land use. In one case a miniature whirl of dust in the schoolyard led to the study of wind erosion and the Dust Bowl. In another, the results of a flash flood and the loss of some valuable irrigated cotton land led

² "Suggestions to Teachers in Guiding Pupil Experience," Pasadena (Calif.) City Schools, 1936.



Sheep are important to this country.

to the study of the watershed, its interrelationships, the delivery of water from the forested area and the rangeland to the irrigated land below.

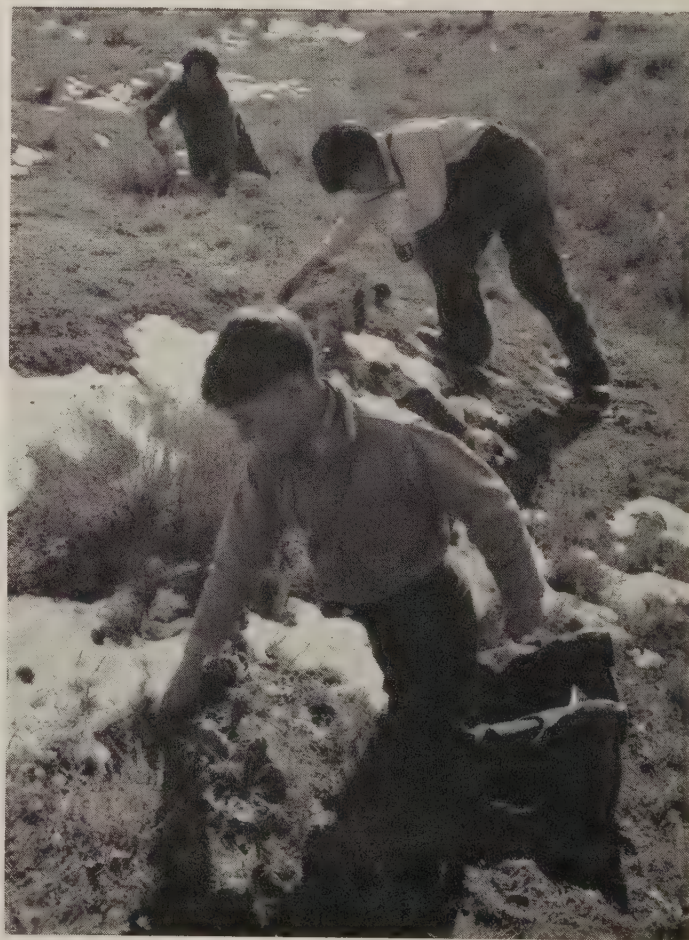
Basic concepts and bodies of subject matter were needed—an understanding of the water cycle, the behavior of soil and water, the growth of vegetation. These were observed and understood and related to the daily living of human beings. Children gained some understanding of the hydrologic cycle in the simple story of a raindrop. Grass as a necessary food for livestock was known to even the smallest child in the Southwest. How grass grew, how it reproduced, how overgrazing and trampling destroyed it, led quite logically to such statements as, "The cowboys should not let the cattle eat in one place too long." Sustained yield of timber on forest land was expressed as the necessity for large trees, middle-sized trees, and little trees. Human use, human needs, human plans and solutions, were the core of each study.

Children have a way of talking about matters that really interest them. Visits by pupils to demonstration areas have led to visits by parents. Parents have written letters to schools expressing their interest and pleasure upon learning that the children are studying land use. In sections where this type of education was going on, the technical men reported an added

interest in the districts and a great facility in obtaining agreements.

The educational superintendents, supervisors, departments of education lent every facility, advised, took over whenever possible. The technical staff of the Soil Conservation Service conducted tours, learned to adapt their language to children's understanding, frequently wrote for us expositions of difficult or troublesome subjects in lucid, simple language. The material on human surveys, from our section of conservation economics, supplied information about the population, its use of land, its economic and social problems. Teachers, recognizing that soil conservation was of great interest to their community, that it helped in the vitalizing and socializing of the whole school program, threw themselves into the program with originality and eagerness.

Our brief experiment has shown that land planning and use has an immediate interest for every school, and that teachers, pupils, parents, and State officials are eager to have a part in it. It is one of the great problems before us today. It has to do with subsistence, with food, clothing, shelter, with taxes, and with many of the problems which are daily a part of home, community, and Nation.



Sixth-grade pupils studying moisture conservation after a snow.

CONSERVATION EDUCATION IN THE SOUTHEAST

By BERT D. ROBINSON¹



Biology students, Alamance County, N. C., see at first hand how gullies develop in pasture land; learn about conservation measures for preventing them.

TODAY public-school teachers in the Southeastern Region as well as farmers are profoundly concerned about erosion. The farmers, of course, have swung into action. Throughout the Southeast they have cooperated wholeheartedly in the erosion-control demonstration projects set up 5 years ago, and now more and more are participating in the programs of the soil-conservation districts. Over a third of the land area of the region is now within the districts.

Educators have had an opportunity to observe and study the new rural pattern being created in the Southeast by conservation farming. They are now stressing the social and economic significance of soil conservation and in the meantime their influence is permeating downward through the high schools into the grade schools.

The work of teachers in the 10 consolidated schools in Alamance County, N. C., in teaching and studying soil conservation in connection with their various social and physical science courses is noteworthy. Here again, as in many other sections of the Southeast, the teachers do not have to travel far to study erosion and soil conservation. First-hand studies can be made within the community.

The school officials and teachers of Alamance County have kept in close touch with the Stony Creek erosion-control demonstration project which embraces about 18,000 acres and with the Burlington C. C. C. camp demonstration area in the county. Furthermore, the teachers have available for convenient observation an independent agency—a farmer-organized soil-conservation district which is tackling the erosion problem on a much wider scale. Alamance and Guilford Counties form the Haw River soil-conservation district embracing 750,000 acres. A memorandum of understanding between the district supervisors and the Soil Conservation Service for technical assistance in conservation planning was effected early this year.

The emphasis that soil conservation is now receiving in the Alamance County schools is not the result of a sudden recognition of the erosion problem and an immediate resolution to bring it to the attention of the school children. On the other hand, the problem had to be studied, its relation to society determined, and teachers had to familiarize themselves with remedial measures in order to make the subject interesting and understandable to his or her students. With this in mind, M. E. Yount, superintendent of the county schools, consulted Prof. George Beecher of the science department of Elon College which is in the same county, asking for help in developing a practical

¹ Associate information specialist, regional division of information, Southeastern Region, Soil Conservation Service, Spartanburg, S. C.

system for giving soil conservation proper emphasis in the schools. Professor Beecher now serves as a consultant in curriculum and other educational matters to the county school system.

After considerable research and study, Professor Beecher produced two mimeographed publications for use by the science teachers in the county's schools. One, *Science and Change in Alamance County Life*, is rich in background material for science studies; the other, *Science Studies in Alamance County Schools*, outlines a cooperative program for improving courses in physical and social sciences through use of community and other teaching resources.

These two publications contain among other things a wealth of material on the erosion problem of Alamance County and the conservation program that is under way in the county. Land use in the county is explained from the pioneer days up to the present. In developing this material and in assisting the teachers in Alamance County, Professor Beecher held to the belief that even the complexity of our modern society can be made understandable to the secondary school students.

In the forepart of *Science and Change in Alamance County Life*, Professor Beecher acknowledges that the rapid advancement of science makes it increasingly difficult to teach. Yet, he feels that the problem is not without solution: "Not only have the conditions of living and modern culture been changed and complicated, but the scientific methods of thinking have become swamped with difficulties of language and technicalities. The sciences are outstripping our ability to understand the most commonplace manipulations or devices. But this state of affairs is partly a frame of mind, partly a tendency to leave science to specialists. The method of thinking has not changed. It is still a matter of exact observation, orderly arrangement of facts, and attempts to understand relationships."

More and more teachers in Alamance County are regarding the community as a vast laboratory. Here the student may see society at work. At first glance the community may appear to be a highly complicated structure and baffling to the mind, but probing beneath the surface under the skillful guidance of the teacher the student discovers that the underlying causes and mechanisms are not as complex as they first appeared. As further study is made the picture becomes more and more clear and its realism affords the teacher an opportunity to leave an indelible impression on the mind of the student.

So, for example, when the science teacher in an

Alamance County school takes his biology class on a field trip there is, as Professor Beecher advocates, "exact observation, orderly arrangement of facts, and attempts to understand relationships." If the class is in a woods it may study the decomposition of woods litter and the soil-conserving value of the litter. At the same time students will note the color of surface soil and moisture content for a later comparison with surface soil on eroded cultivated land. This, of course, is only one of the ways in which students in the Alamance secondary schools develop a better appreciation of the erosion problem and the need for soil conservation. At some time or another during the study of other science subjects soil conservation is properly introduced; and, instead of depending entirely on textbook and other written material, the teacher and the class leave the school and use their community as a laboratory.

Thus far, conservation education in the Alamance County secondary schools has been designed mainly for high-school classes. Serious thought is being given however, to the development of a similar approach in the lower grades.

Throughout the Southeast the Soil Conservation Service is frequently consulted on two significant aspects of conservation education—one concerns teaching material and the other school and classroom procedures. During the fiscal year ended June 30, 1940, the regional office at Spartanburg, S. C., received nearly a thousand requests for teaching material. In many instances teachers were supplied with localized material so that they could focus the students' attention more effectively on erosion problems and conservation programs near their homes. The Service does not attempt to develop teaching procedures or methods, as these can best be handled by the teachers and State educational officials. However, the names of teachers who have developed successful methods are suggested as sources of information so that the benefits of their experience may be utilized.

A few years ago college and school libraries in the Southeast had relatively little material on soil conservation, but today many have rather complete collections of books and other publications on the subject. Teacher colleges are placing considerable emphasis on the development of "materials bureaus" for serving not only students in attendance at the college but also public school teachers in nearby communities. The State Teachers College at Troy, Ala., for example, is making a special attempt to acquaint teachers in nearby counties concerning the material available. At an educational conference held



Alamance County pupils examine the decomposition of woods litter and the protection it affords the soil. Also noted are the color and the moisture content of the surface soil as compared with the surface soil of eroding cultivated fields.

at the college during July, considerable emphasis was placed on the need of conservation education in schools. College officials also requested the assistance of technicians of the Service on field trips to erosion-control demonstration areas and soil conservation districts. Assurance that the technicians would gladly help was immediately given by the State coordinator who had been requested to attend the conference and offer suggestions for advancing conservation education.

State coordinators frequently are asked to assist colleges and schools in their conservation courses. This not only calls for appearances in the classroom but on field trips to demonstration areas. When the State coordinator is unable to participate, arrangements are made so that an area technician will be available.

Vocational agriculture teachers in the Southeast have been quick to utilize the erosion-control demonstration projects and soil conservation districts for teaching soil conservation. They are also furnishing

effective assistance to the district supervisors in getting conservation farming practices established through student contacts with farmers in their communities as well as in their adult night classes.

"The district program has given me a basis for teaching vocational agriculture which I never had before," remarked C. C. Reed, vocational teacher in the Sardis community school in the Hart County unit of the Broad River soil conservation district in northern Georgia. "My boys can get more out of seeing good farming practices combined into a unified program on one farm than they could get from a whole textbook of explanation.

Vocational teachers, however, have pointed out the need for a compact publication, for use in the classroom, that contains essential information on soil and moisture conservation and lists of suitable references. They suggested that such a publication be developed on a State basis rather than regional, so that specific

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NATIONAL RESOURCES AND THE WORK-SHOP IDEA

By HELEN M. STRONG ¹

EDUCATION within the past 2 years has taken a most significant step regarding natural resources, based upon the relation of the child or more mature student to the community and the region in which it is located.

When the local community and the home largely were self-contained, through participation in community work, boys and girls attained a consciousness of their intimate dependence upon the community and community resources. Today, the necessities of life come from the store to the home, instead of from field, forest, stream, or mine. Consequently, stores and factories are realities, but their direct dependence upon natural resources often is too little realized.

Paul R. Hanna, professor of education at Stanford University, through studying the role of regionalism and the community in education, became aware of the fundamental influence of natural resources in every region and community. In fact, it is differing combinations of such natural resources as climate, soil, land form, water and mineral resources, native vegetation, native animal life, location, and area that are responsible for the basic regional framework of the United States and other countries. People have developed regional social and economic patterns through use of regional natural resources.

All this brings the educator face to face with the principles and problems expressed in the "Role of Education in Utilizing Regional Resources."² Because leading educators are convinced that sound use of natural and human resources is essential to future well-being in America, they believe that an understanding of this vital relationship must come through education.

Geographers and sociologists have emphasized the significance of the natural region. Harlan H. Barrows, consultant of the National Resources Planning Board, in his presidential address before the Association of American Geographers spoke of regional geography as the "culminating branch of the science." An eminent sociologist and educational leader, Howard W. Odum, in his "Regionalism" has emphasized the human aspects of the region.

Educators have assumed leadership in bringing about an understanding of the interrelationship between

natural and human resources. They have asked subject-matter people, natural and social scientists, to aid them, and have organized the Commission on Education and Resources. It is sponsored by the National Educational Association, the Progressive Education Association, and the United States Office of Education, each of which is represented on its membership. Paul R. Hanna is its chairman.

The commission, with a few invited consultants, met at Reed College in Portland, Oreg., for 10 days early in June 1940. It was my privilege to share in their deliberations as one of the consultants. We considered present educational understandings about resources, as resources are related to the present and future of the United States; the place of resources in education; and the approach to integration of resource teaching into classroom activities from kindergarten through teachers' college and university.

Members of this conference held a deep conviction that the following understandings, fundamental to the Nation's future, must come out of education: That the America of today has evolved out of the human use of natural resources; that human activities and natural resources basically are regional in character; that America must recognize the need for sound practical use of natural resources in the best future interests of the country; that two futures present themselves—one downgrade, the other, upgrade, according to the use made of natural and human resources; that America must act accordingly in using its natural and human resources; and that education is a fundamental factor in achieving an understanding use of natural and human resources.

In order to develop an understanding of all these resource relations to American life the commission believes that these are some of the educational needs: To sensitize teachers to natural and human resources and their relations to life; to provide materials in the way of publications and teaching outlines; to afford in teacher training an understanding of natural and human resources, and of the techniques for relating them to teaching activities.

The commission provides a focus of educational action that will sensitize teachers, educators, children, and adults to their dependence upon natural resources. It will sensitize them to the need for public school and college education to act in order to preserve national

¹ Formerly in charge, educational relations, division of information, Soil Conservation Service, Washington, D. C.

² Paul R. Hanna and Harold C. Hand, Stanford University, Calif., and the Progressive Education Association, New York, N. Y.

human and natural resources through wise use. Through education it will implement the work being done by private, State, and Federal agencies working toward spread of sound practices in the use of land, minerals, soils and waters, wildlife, forests and grasslands.

The commission has undertaken a fundamental task essential for maintaining the natural and human resource foundation upon which the life of the American Nation depends. It is leading the way for teachers and educators to bridge the gap between an objective knowledge of human problems, of topsoil, minerals, waters, climate, area, regional location, forests and grasslands, and a subjective understanding of their personal relation to every individual and every community. It is pointing the way for teachers to weave these facts into their classroom work. Out of this will come an understanding, from the grades, through the university, that will eventuate in constructive action for sound resource use in the interest of each community, each State, and the Nation as a whole.

This summer the commission centered its efforts on an intensive workshop program in the Pacific Northwest, and less intensive institute and study projects in the Southeast. Syracuse University and the Harvard Graduate School of Education, in their summer workshops, also dealt with regional resources. Key educational leaders limited to 150 in number registered in the workshops at Reed College in Portland, Oreg., and the University of Washington at Seattle. For 6 weeks these leaders worked on projects, outlines, ways and means of weaving resource teaching into areas of human living, and into subjects taught in their school systems. University credit was given for this work.

The staff of the workshops and the commission consultants were routed successively to all the teachers, colleges and schools of education in the Pacific Northwest. For a week at each of these places a resource institute was held, attended by all the classroom teachers registered for summer work. In this way, thousands of classroom teachers heard resource facts presented, and in group or individual discussion grappled with their personal problems of resource teaching.

A similar but less intensive activity in the Southeast included George Peabody College for Teachers, the University of North Carolina, University of Kentucky, University of Tennessee, and the State Teachers College at Troy, Ala. At Peabody, 1,500 teachers and educators attended the curriculum conference where community life in its resource relations—

human and natural—was considered from the point of view of the classroom teacher. For 10 years, Peabody has been holding such conferences annually, and has had a workshop group dealing with curriculum problems. It is significant that here and elsewhere through the South and Southeast, faculty leaders are thinking of the region and its resources as connected with everyday classroom work. Next year workshops in these and other universities plan to work on problems and projects dealing with the place of regional resources in classroom activities and the curriculum as a whole.

CONSERVATION EDUCATION IN THE SOUTHEAST

(Continued from p. 93)

recommendations on conservation practices could be included. Verd Peterson, State supervisor of the division of vocational agriculture and home economics, South Carolina Department of Education, had sensed the need for such a publication for some time and last spring at his request the Soil Conservation Service in cooperation with vocational teachers and specialists of Clemson College prepared the teaching material.

Virtually all phases of soil conservation for South Carolina are covered in the publication. Needless to say the heads of vocational departments of other Southeastern States also are interested in developing a similar type of publication for their teachers. The South Carolina publication will, no doubt, serve as a suitable model for work of this kind.

The results of conservation teaching in the Southeast, as elsewhere, cannot be measured by a yardstick; nor will an imposing array of statistics give a true picture. Moreover, the work that the educators are doing in this field will not produce its maximum benefits until youth reaches manhood and has the full responsibility of safeguarding our land resources. The present job is to make the mind of youth capable of sensing and understanding the full significance of wise land use and that conservation is essential for the future as well as present security of the Nation.

Fortunately, youth in the Southeast has a much better opportunity for studying conservation than the present and preceding generations had. Virtually every land-grant college in the Southeast lists in its curriculum courses on soil conservation. In addition, approximately 25 other colleges offer regular conservation courses in which soil conservation is stressed. These institutions and the public schools constitute a formidable defense against which the forces of erosion can hope to make but little, if any, headway.

THE CURRICULUM AND SOIL CONSERVATION

By CYRIL W. GRACE ¹

THE processes exhausting our resources are not ills that may be fixed upon a particular era or administration, but rather the development of a way of life dating from the earliest settlement of this country down to the present. We have now reached that climax from whence we must begin the long process of restoration, conservation, and a continuous practice of thrift if we are to be assured of a continuous democracy. The degree of political democracy, in the final analysis, will be conditioned by economic democracy. The two are inseparable.

It is obvious that the elements of conservation of necessity must be ingrained in the customs of the people. The common school has been the natural institution provided by our democratic form of government to assure the nation of continuous progress. The philosophy of the common school is largely motivated by the teacher-training institution. Preliminary investigation and applications, limited in nature, therefore become necessary in the teacher-training institution before any valid curricular materials or techniques become general practice.

The theory of the Mayville experiment, as the work of this teachers' college has become known, is premised upon a theory of collegiate organization. The essence of the experiment is that a teacher-training institution should be prepared to deal with certain basic problems of the area it serves, and to train the forces of its several departments upon these problems in such a way as to provide for the passive understanding of the adult public as well as for the future general welfare through the education of children. Soil conservation is basic and essential to the general welfare of the agricultural population of this area and it was for this reason that the college was chosen as the starting point for the experiment.

The approaches to the problem have been varied. Throughout the first year of the experiment, the president's weekly convocations dealt with the present economic and social condition of the State and the relationship of these conditions to the exhaustion of natural resources. The convocation lectures served as a point of coordination for the many activities that developed, as well as a process of orientation. From time to time conferences were held with A. W. Emerson of the Soil Conservation Service, in developing plans for discussions in regular classroom work on

the erosion problem and modern methods of conservation.

A conservation committee was appointed from the faculty. This committee was composed of the head of the science department, Dr. Harold Burdick, Miss Ellen Johnson of the rural education department, Prof. Harold Addicott of the geography department, and the president of the college. A coordination of the work of these four departments represents an attainment in itself.

All materials produced by the committee are tested in the training schools affiliated with the college. The results have been most gratifying. Seldom is a visit made to one of the seven affiliated training schools for practice teachers that pupils are not found constructing terraces on mounds of soil carried into the schoolroom in the ashpan or in a discarded dishpan brought from home by one of the children. Strip cropping pictures are being drawn, bird houses constructed, trees planted in the schoolyard, or any one of the many conservation activities of interest to school children may be in process of study. These children are living and enjoying their environment. They are learning the relationship of success in farming to good land-use practices. In addition to the developments of new techniques and materials, new understandings of the problem have developed on the part of the faculty participants.

Other departments are now devoting a portion of their time to this particular problem. For instance, the library, under the direction of Prof. Hazel Byrnes, has developed a unique package library. Books and materials pertaining to the many aspects of conservation are wrapped in packages and called for by teachers who agree to supervise the circulation of materials in the neighborhood of the school, among adults as well as children. When through with a package, this teacher rewraps the books and sends them on to a neighboring school. Ultimately, after the package has visited several communities, the material arrives back at the college and is made ready for another visit.

Prof. Hans Lee, of the music department, encourages classes in composition to develop songs pertaining to many aspects of rural life and to soil conservation.

The art department, under the direction of Prof. Eugene Myers, teaches the teacher, who in turn will teach the rural children, to draw and paint pictures

¹ President, State Teachers College, Mayville, N. Dak.

of their environment as it is, and as it may be. It is interesting to see teachers drawing pictures of contour and strip farming, and then to see the student teachers in our rural schools directing the activities of the children along similar lines.

The extension soil conservationist, in cooperation with the local county agent, the Soil Conservation Service, and local farmers, has established two demonstration farms nearby, for observation by college students and elementary school pupils. It is not uncommon of an evening or late afternoon to see college students on tour, studying the various conservation practices and discussing with the farmer his farm plan and the whys of many of his operations.

Under the direction of Prof. C. O. Mehuse and Frederick Weigle, a public forum committee is developing techniques whereby the young school teacher may learn the processes of engaging the adults of a community in problems of vital interest to them, including soil conservation. We realize that the young teacher, in all probability, will not be able to assume platform leadership; but with patterns and blueprints available, she will know how to develop the innate leadership available and to use it in the development of the community center.

Short courses in the field of conservation are held each year. The United States Department of Agriculture has cooperated during these 2-week periods by sending experts in the various aspects of conservation to the campus to lecture and demonstrate the latest and most approved methods. The Soil Conservation Service has been especially cooperative in this respect by furnishing leadership in the development and guidance of these courses. Student interest has been high. These short courses are taken voluntarily, and offered without credit. At their late afternoon and evening sessions the attendance frequently exceeds 100 students. Inasmuch as freshmen and juniors do not participate, and in view of the fact that our enrollment in this college is about 500, this should indicate how a student body will respond to the needs of their State if emphasis is given in several departments to a particular problem. We also offer a course on conservation for credit during the summer session. Each student, when leaving the college to take up teaching, receives a list of all Soil Conservation Service demonstrations in the area adjacent to the location of the school where she or he will teach; these demonstrations can then be used for observation and as teaching aids. Several other departments offer assistance in this field of interest, but

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Elementary-school children stop for a discussion of the farm plan with the farmer.

THE LAND AS A TEXTBOOK

By ANNE RAYMOND¹



High-school tour, Mount Chusko, Navajo Reservation. Spanish, Indian, and Anglo students learn the principles of revegetation.



Little children from Tucson, Ariz., know that "grass tacks down land and catches rain."

WE USE a phrase with our teachers and pupils, "The Land is the Textbook," which gives the spirit of our work in the Southwest. Perhaps it was sheer necessity at first because there was little if any written material to help us in our particular situation and we ourselves of necessity had to follow the surveys, the research, the methods which were constantly being developed by the many technical men working with the land and its resources.

We all began in the same way. We walked on the land and studied how nature works; how soil and water behave.

We took this land apart in our thinking. We saw the ways in which living things grew bigger and

better or gradually fewer and smaller and perhaps even disappeared. Our first necessity was a knowledge of certain basic concepts:

1. The water cycle.
2. The "balance of nature," or the interdependence of animals and people, land and water.
3. The growth of a tree: Its parts; its value as vegetative cover.
4. Grass and its contribution as a vegetative cover. (Grass manufactures its food in the leaf or blade and stores its food in the root, stem, and seed; it must have opportunity to grow sufficiently to reproduce.)
5. Ground litter: What it is composed of; its value. (Ground litter increases absorption, slows run-off, filters the rain, decomposes to form nourishment, slows evaporation, etc.)

In our study of the land one of our first approaches to this new knowledge is a careful study of Russell Lord's bulletin, "To Hold This Soil"—the first invertebrates in the sea, and then the succession of vertebrates and amphibians, dinosaurs, and mammals. We are able to go with our yardstick and measure the footprints of the dinosaur that walked in Arizona, New Mexico, Colorado, and Utah. His bones have been dug up by scientists of today and reconstructed to show the skeleton of this huge reptile.

Finally in our picture we see man on the earth. We see him through his period of struggle with the glaciers. We see him traveling with Coronado in

¹ Associate information specialist, regional division of information, Southwest Region, Soil Conservation Service, Albuquerque, N. Mex. This article is based on material presented by Miss Raymond in a talk before the Pacific Northwest Resources and Education Workshops Conference in July 1940.

the Spanish conquest and arriving with the Pilgrims in a boat on the eastern shore of North America. Now at last we are in "today." We have watched the long sequence in nature as it established a certain balance and today, as then, soil and water run to the sea if soil is not tacked down or caught for use. It is an easy transition from this story of the earth in panorama to a journey to the highest spot on our watershed.

From a school in Arizona there comes a picture story, together with reading charts and vocabulary lists of man's travels from the eastern seaboard to the settlement of Arizona. We see him as a Pilgrim clearing the forest, putting in his corn, developing his simple agriculture. Then forced by conditions to move onward and onward, he travels farther and farther west. He settles near a stream in Arizona. We see in the picture story the coming of the stockman with his sheep and his cattle; the gradual loss of vegetation and constant loss of soil. Now we see the man on the land gathered with his neighbors around a big table working out a plan to save the land of Arizona.

Here is the student's problem that gets to the heart of land use:

A man had 120 head of cattle on a section of good grassland. After many years of neglect and erosion he could put only 40 head of cattle on his section. How many acres were needed for each head of stock before the neglect and erosion? How many acres are needed for each head of cattle after many years of neglect and erosion?

Near one school in Arizona a tiny whirlwind of dust gathered force and twirled across the schoolyard. "What is that?" asked the teacher, and the reply came from a small child in the classroom: "Kansas!"

The teacher smiled. "I hardly think it is Kansas, but perhaps we had better go and see for ourselves."

Out they tramped, teacher and children, to find the answer. Other little flurries of wind were carrying dirt hither and yon in tiny twirls and all of it gradually was leaving the schoolyard.

"It's our school ground blowing away," they said. With serious faces they considered this problem.

"Look, Miss D——, it doesn't blow the dirt down there."

Just beyond the schoolyard was a little church and beside the church a fenced-in cemetery. Green grass waved in the breeze.

"Let's go look at it."

So over went the children to the churchyard.



Irrigation, so necessary to their valley, is accorded serious contemplation by these school boys and girls of Santa Fe County, N. Mex.

"Why, it's the grass," they all exclaimed. "Look, Miss D——, the grass has roots in the soil holding the earth like tiny little fingers."

"See," said another, "see the great roots of that tree running down into the earth."

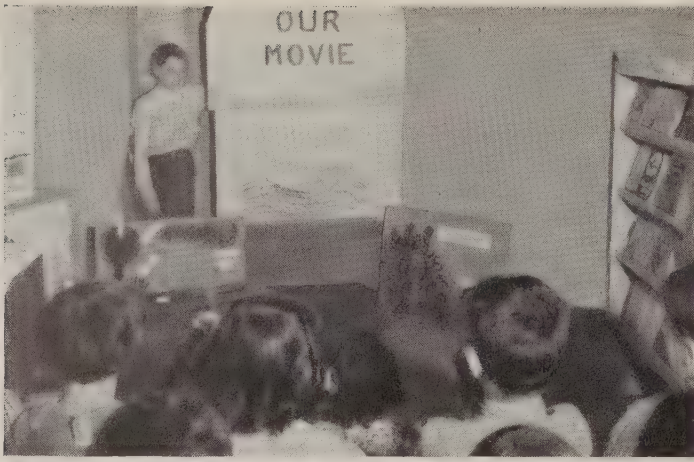
They gathered a handful of grass with the roots intact and tramped once again back to the schoolroom.

Each day was a new adventure of discovery and experiment. They planted seeds in four boxes, two with good soil which they brought from the woods and two with poor soil from nearby. They planted seeds in all four boxes. One good box and one poor one were left without water. They watched day by day to see in which box the seeds grew best.

When I visited the school a few weeks later, this is what I heard: "Seeds need water or they dry up and can't grow—they grow best in good dirt. When they grow into plants, the plant blades catch the rain so that it can run slowly into the soil. The plant roots hold the soil, and everything works together."

They showed me their class readers which they themselves had made day by day. Each child had a book illustrated by himself. The books had four stories based on the fascinating subject of soil and water.

The first story told about the raindrop. The rain-



Third-graders make the study of wheat the basis for a "moving-picture" show.

drop in the ocean was taken up in vapor as the sun warmed the air.

In the second story, the cloud filled with many raindrops reached the cool mountaintop and the vapor turned to water again and fell as rain to the earth. One raindrop fell on trees and grass. It hit the earth lightly and ran down over a leaf, through the twigs, and into the ground. It gave the flowers a drink, the trees a drink, the grass a drink, and then ran out into a cool spring. The children found the spring on a picnic trip and they exclaimed:

"There is that raindrop—it will go down this brook and then to the river and on to the ocean. This raindrop has served everybody and now it will carry food to the fish in the ocean."

The next story was about another raindrop. This raindrop did not fall on the trees and grass. It fell on the earth which was brown with dust. Down the slope it ran gathering other raindrops and soil as it traveled; dirty now, not clear raindrops, and running faster and faster. They tear holes in the land as they run—down to the river and away to the ocean, serving no one and carrying away the farmer's fields, the city streets and highways; back to the sea, filling the fishes' gills with silt, all because there was no grass or trees to catch them.

These little children had simplified the story of Earth's needs: Vegetation to hold the soil and catch the rain; wise land use to maintain the necessary balance between earth and sky and animal and man—basic concepts from a day-by-day study of life and living.

Thus runs the story of one small group who studied soil and water and how they behave. I asked the teacher if it was difficult to develop the story and keep them interested.

"Difficult," she said, "why, they wouldn't let me stop!"

In many high schools of the Southwest, through their land study programs, there grew a simple outline. This covered the virgin land as to topography, geography, water supply, and general balance in nature. Then, man's impact upon nature: His early settlements, influence on vegetation, on water supply, on animals, and a summing up of the results of this use of the land.

This was followed by suggestions for developing a land-use program—appraisals, watershed planning, uses of water, study of importance of vegetation, city planning, etc. Certain methods were suggested for developing the study through maps, graphs, photographs, lantern slides, work sheets, etc. The outline ended with recommendations as set up by the student group.

In this subject of conservation—of man and man's resources—I believe the most important thing is for us to set up a few simple concepts which become clearer to us day by day. They will become clear as we use them, talk about them, find evidence to substantiate them, and at no time will we feel that we have completed them. Experts on any one of these simple subjects are making life studies; today they have reached only milestones, not a finished goal. The water cycle, the growth of trees and grass, ground litter, a watershed, the behavior of soil and water, these are basic understandings which every teacher will have to take as her first objective.

At the close of the program, each teacher should feel much better equipped to go back to the land with a new delight for another year of new discoveries. It is important that there be no such feeling as expressed by one teacher, "I taught that last year." It would be as inconsistent as to say that the grass grew last year so we do not need it this year. There is new knowledge and more adventure forever and forever in the study of this world about us and it is important that we feel ourselves on a journey rather than on a trip.

In 1939 a cooperative summer school devoted entirely to the teaching of conservation and school-community relationships was set up at Norris, Tenn., in cooperation with the University of Tennessee. In 1940 the Norris Summer School was continued, and other activities were enlarged to include intensive work during the regular school year in selected counties where the educational authorities and teachers have manifested a desire to emphasize conservation.

SOIL CONSERVATION IN ELEMENTARY AND SECONDARY SCHOOLS

By TOM DALE ¹

A FEW weeks ago I attended a class in curriculum building for secondary schools at the Kansas State Teachers College at Emporia. Ten teachers and principals from Kansas high schools were enrolled as graduate students. Dr. H. G. Lull, head of the department of education at that institution, was the instructor. As he called the roll, he asked each student to explain the work he was doing.

The first student said that he was making a study of the social aspects of accelerated soil erosion in the United States—seeking information as to the effects of soil wastage on the standard of living in the communities and homes affected; acquiring facts about the effects of erosion on the industrial, economic, and social life of the Nation, the State, and community. But he was carrying his plan of study further still: As soon as he was satisfied that he had correct information about these problems, he hoped to devise methods of integrating it into the high school curriculum. It was his opinion that such information should be emphasized to a greater extent in the social studies, in American history, and in the social sciences of the Kansas secondary schools. He expected to make specific recommendations as to when and how this material might be introduced into these high-school classes.

Another student was studying the history of soil erosion and conservation in foreign countries and attempting to integrate his findings into the studies of world history and other subjects taught in Kansas high schools. Still another student was trying to decide what the physics and chemistry instructors should teach about the mechanics of soil erosion and commonly used conservation practices.

As the roll call was completed it became evident that each of the 10 students was making a study of a different phase of the soil erosion and soil and water conservation problems and was attempting to make specific recommendations as to how these subjects might be given their proper place and emphasis in the teaching program of the secondary schools. The class was meeting for an 8-weeks' period, and approximately one-half of the time was devoted to these land-use studies. The balance of the time was taken up with similar curriculum building activities on the conservation of human resources and the other natural

resources of this prairie State. It was very interesting, and I felt that this small class might be doing a piece of work that will have national significance.

A 5-day conference on curriculum building was held during this same summer session of the teachers college at Emporia. Some 300 school teachers attended the conference. During the first 2 days, general problems of curriculum building were discussed. Particularly interesting was a discussion on the need for building a school curriculum to fit the aptitudes and characteristics of the pupils, and around problems of the homes and community.

The last 3 days of the conference were devoted largely to a study of land use and conservation problems of the State and the need for further emphasis on these vital matters in the elementary and secondary school curricula. A field trip to study the land and see erosion control practices at first hand was a feature of the conference. Dr. Lull declared that this curriculum conference was but a beginning of the efforts of his teachers training department to inject into the elementary and secondary school curricula a more complete and balanced study of Kansas resources and their conservation.

In 1940, for the second consecutive year, the West Texas State College at Canyon made a 6-weeks' course on the conservation of natural resources a special feature of its summer session. This year about 90 teachers were enrolled. Approximately one-half of the time was devoted to the study of better land use and soil and water conservation. The objective of these courses is to stimulate the teaching of conservation in the public schools.

At Boulder, Colo., the dean of the extension service of the State University decided last winter that the problem of soil erosion control was more than an agricultural problem in his State. He requested the Soil Conservation Service to cooperate with his institution in holding a 3-day special conference for summer school students on the subject "Conquering the Dust Bowl." The geography, geology, biology, education, sociology, and other departments of the university helped to make the conference a success. The Chief of the Soil Conservation Service appeared as the principal speaker and other addresses were made by regional leaders in the conservation movement from this Service, the Forest Service, and the faculty of the university.

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The authorities at the university were so pleased with the reception of this initial effort that they are laying plans for a similar conference on a broader subject next year.

Faculty members of the State Teachers College at Greeley, Colo., in their efforts to emphasize the conservation of resources in curriculum building, called on the Soil Conservation Service for assistance. A speaker from the Service explained the soil erosion problem and its solution to several groups of teachers attending the summer school. His remarks met with an enthusiastic reception, and many seemed suddenly to realize that they had not given these matters the emphasis deserved in their curriculum building work of the past.

These are but a few of the teachers colleges, universities, and other nonagricultural colleges that have become actively interested in conservation education.

Public-school administrators and teachers in all regions seem to be thinking on these vital problems and, certainly, this attitude indicates a trend. How many teachers are keeping pace with the trend? If we are to build a firm foundation, conservation education must be universal. The development of habits of thinking among the citizenship, to the end that conservation will become a fundamental policy of the State and individual, should be the ultimate objective.

People usually think according to habits acquired over a period of time. In a country whose present generation has seen many fortunes made by the exploitation of natural resources, and where the majority have at some time profited from such exploitation, thinking in terms of conserving these resources cannot be the general rule until public attitudes change. The elementary and secondary schools seem a logical place to start bringing about this change.

SCHOOLS TEACH LESSONS FROM THE LAND

By WALTER W. JOHN ¹

FARMS and forests are becoming conservation classrooms for schools in the Upper Mississippi Region. The demand for soil conservation educational material is one of the best indications that teachers are using lessons from the land for classroom instruction. Teachers welcome up-to-date material on conservation. Thousands of soil conservation publications have been placed in the schools of Illinois, Iowa, Minnesota, Missouri, and Wisconsin within the last year. These publications were obtained from exhibits at education meetings, through mailing lists, and by direct request. The regional office filled more than 1,500 written requests from teachers for bulletins and visual aids during that period. About half of the requests were received at exhibits during education conventions.

Soil conservation exhibits and publications were displayed in this region during the last year at the national conventions of the National Education Association, Progressive Education Association, Association for Childhood Education, and Central Association for Science and Mathematics Teachers. The Service also participated in annual teachers' conventions in three States and in a number of district conventions and county institutes.

Nearly all of the 34 teachers colleges in the region are offering courses in conservation and are using soil conservation publications and visual aids in these and

related courses. They are supplementing their conservation instruction with field trips where students gain first-hand information on the condition of natural resources and methods of proper use and protection.

The field study has just been mentioned as one teaching supplement; it is perhaps the most fundamental aid to instruction in any conservation course. It utilizes the farms and forests as classrooms. Louis Agassiz, noted naturalist and early conservationist, said, "Study nature, not books." Teachers today find that they can get best results by studying both nature and books. The many recent publications on soil conservation serve to point the student's attention to the actual source of information—the land itself.

Visual aids unquestionably have the greatest appeal to the student and at the same time tell the story of conservation effectively. Included in this category are movies, lantern slides, charts, exhibits, photographs, film strips, and special display material.

The universal appeal of soil conservation to all ages and groups of people is typified by the excellent reception of the movie "Once Upon A Time," written by J. N. "Ding" Darling and produced by the North American Wildlife Federation. Simple enough to be partly understood and thoroughly enjoyed by all school children, it also carries a powerful message to the grown-up, whether he is a teacher or a technician. "The River," filmed by Pare Lorentz, is a masterly production that reaches the heart of the problem and

¹ Regional division of information, Upper Mississippi Region, Soil Conservation Service, Milwaukee, Wis.

awakens the public mind to the task of conservation. Both of these movies and many others have been widely used in classes ranging from the third grade to the twelfth and for adults generally.

The Soil Conservation Service maintains a supply of suitable movies, colored lantern slides, film strips, and exhibit material for loan to schools and educational groups. Charts and many publications are available to teachers and libraries without cost.

Children have always enjoyed studying about trees, birds, flowers, and animals, but until recently the soil has been a mystery locked beneath Nature's blanket of growing things. The young mind is fascinated by teaching processes that reveal this mystery as a natural process from which most life springs. It may be difficult for the third-grader to comprehend the meaning of topsoil and its full value, but a brief study of an eroded field, a roadbank, or other exposed soil profile easily explains it to him. By the time he reaches the eighth grade he will be able to grasp the meaning of soil conservation, whether he lives in the country or in the city. Soil conservation has many stories that can be told in a fascinating way. Movies, colored slides, and classroom drawings add immeasurably to children's interest in the subject. Sand tables and model farms are excellent aids to instruction. Field studies, which are being used by many teachers, are recommended as of first importance.

To obtain proper recognition of conservation, State departments of education and teachers organizations are issuing special curricular material on this subject for public-school teachers. Two States in the region have revised their curricula to include conservation outlines in their course of study. The other three States have prepared supplementary publications on conservation which teachers may adapt for classroom use.

Soil conservation should not necessarily be studied as a separate course. It is closely related to other subjects taught in public schools and teachers find that it can be taught best in conjunction with these courses. For example, students of biology and other natural sciences concentrate on the study of life in man, plants, and animals and the processes by which it develops. Since the soil nurtures life, a study of biology is not complete unless it shows the natural relationships that exist among man, plants, animals, and soil and the necessity of conservation of soil for the benefit of the other three.

Geography, the science of the earth and its life, is particularly well adapted for the inclusion of soil conservation. Any study of geography should correlate

the effects of climate, water, vegetation, and man's activities on the soil.

The map is one of the most essential visual aids used in geography. Today, new maps are making the study of soil conservation easier for the geographer. Soil conservationists are preparing maps to show what erosion has done to the soil and how it can be controlled. Geography teachers are making use of these maps and preparing others in their classes as an effective method of teaching conservation to their students.

Social sciences discuss the social ills that result from impoverishment of the land. Teachers of sociology courses encourage their classes to trace the sociological effects of land decline on both rural and urban communities. Students of government find particularly interesting the new types of local public agencies, such as soil conservation districts, that have been developed especially to protect soil resources.

In agriculture courses students are trained for action in soil conservation. They are taught the practices necessary to conserve the soil and how to apply them. This is especially true in vocational agricultural classes where farm boys are including soil conservation practices among their work projects.

Even in courses in arithmetic, art, history, and other subjects, soil conservation is receiving attention. Experiment-station data and erosion-reconnaissance figures provide problems in arithmetic; a strip-cropped field is a fit subject for a painting; and the historian cannot overlook soil erosion as a factor in the downfall of nations.

The educational service of the Tennessee Department of Conservation began in 1937 to stimulate preparation for better teaching of conservation through conferences, illustrated lectures at teachers' meetings and institutes, field trips and demonstrations, and by distribution of a magazine published by the department and free to every school in the State. Now, according to James L. Bailey, educational assistant for the department, every teacher-training school in the State, with one exception, has added conservation to its curriculum. The subject is taught in such a way that teachers and student teachers learn to interpret the need and means of conservation in the light of problems real to the localities in which they work, and also those which are the concern of the State, region, and the Nation.—F. E. Charles.

TAR HOLLOW CONSERVATION-TEACHING LABORATORY

By F. E. CHARLES¹

WITH arrangements made for teachers, or undergraduate teacher-trainees, to obtain full collegiate credit for their work, the conservation-teaching laboratory was held in the Tar Hollow group camp deep in the hills of Ross-Hocking State Forest in Ohio, an 18,000-acre land-utilization development. At the outset of the 5 weeks' course, each student was given a 2-acre tract for study. Working in pairs, if they preferred, students studied their plots in minutest detail. They mapped them for elevation, cover, vegetation, soil type, bird, and animal life. They brushed away leaf litter under the trees, examined the soil with its myriad of life processes. They charted the habitats of birds and mammals.

After a visit to the Tar Hollow camp, Dr. Frank Thone made the following remarks: "Most particularly have I been impressed with the study-plot program, including as it does all ecological activities and events in the areas under observation. All ecologists whom I know were trained specifically in only one part of the field: They are either plant ecologists, or animal (i. e., mammalian) ecologists, or insect ecologists, etc. That is, they are fractional ecologists, incomplete ecologists. A student who has worked

by the plot method employed here becomes an ecologist of the whole biota, a total and complete ecologist. For the good of ecology I hope the method will spread."

This plot work progressed daily for 5 weeks. When not "plotting," the enrollees studied with the faculty—Dr. Dwight Moore, plant ecologist; Dr. Lawrence Hicks, animal ecologist; Prof. C. F. Moses, geologist; Dr. A. C. Bunce, economist and sociologist; or their Tar Hollow university "chancellor," O. E. Fink, director of the laboratory, brought in such lecturers and conservation-teaching pioneers as Dr. Paul B. Sears who wrote "Deserts on the March"; Dr. J. Russell Smith of Columbia University; Dr. Willis Sutton, superintendent of the Atlanta, Ga., schools; Dr. O. E. Baker of the United States Department of Agriculture; Dr. Frank Thone, editor in biology for *Science Service*.

There were many other visiting speakers, including practical farm planners of the Soil Conservation Service, whose discussions were combined with a tour in a soil conservation C. C. C. camp truck to the nearby Chillicothe camp area. Here each student, faculty member, and visitor studied land-use and conservation-farming maps. They walked across each field, rationalizing field arrangement with the plan adopted.

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Instructor Arthur Harper identifies a plant species along the nature trail.

SUMMER PLANNING FOR WINTER STUDIES

By FRANK B. HARPER ¹ and C. C. JOHNSON ²

SOIL conservation was high on the list of subjects considered this past summer in the two education workshops of the Pacific Northwest. The workshops were held during the summer period, one at the University of Washington summer school at Seattle, and the other at Reed College in Portland, Oreg. Both of these curriculum-revision studies were sponsored by the Northwest Regional Council and the Commission on Resources and Education. Soil Conservation Service participation was arranged through Service representatives and Dr. K. O. Warner, director of the Northwest Regional Council, who invited the Service to join with other sources of technical authority to work with the teachers in their search for ways of incorporating natural-resources and other vital every-day subject matter into the school curriculum at various educational levels.

When, near the middle of June, approximately 150 of the educators went to work at Seattle and Portland, the Service was prepared to supply them with the essential facts on the subject of land and its use. During the month-long workshops, this assistance included talks and personal consultation with the workshop groups by the regional educational relations representative, and special discussions given by Dr. Helen Strong, Miss Julia B. Tappan, Miss Anne Raymond, and educational relations representatives of the Albuquerque office of the Soil Conservation Service. Bulletins and other reference material were supplied, and pictorial exhibits were set up at each workshop.

The workshop students made several planned tours to study in the field the subject matter with which they worked in general sessions and group panel meetings. Two of these tours, under the direction of Joseph T. Hazard of the Seattle schools faculty, were to Soil Conservation Service C. C. C. camp areas.

The greater number of the 100 University of Washington workshop members spent a day on the Snohomish camp area, where both men and women teachers explored fields and pastures, streambanks and woodlands, and learned from cooperating farmers and Service technicians how they go about the developing of farming, forestry, and other land-use practices.

A similar week-end excursion took the half-a-hundred Reed College workshop teachers to the camp at Warrenton, where they saw the successful sand dune erosion-control work along the north Oregon coast and also learned about streambank erosion control, seeding of cut-over timberland and other soil- and moisture-saving operations.

If the 1940 workshops appear to be of sufficient value to warrant broadening the experiment into a regular program, it is planned to have similar workshops in the future in every section of the Northwest. The hard work and enthusiastic comments of this year's participants indicate that this plan will be carried out. They were in agreement with the thought behind the workshops—that the misuse and exploitation of natural resources is due largely to a lack of appreciation of their importance, and that the schools have the big share of responsibility in developing such an understanding among today's pupils who will be tomorrow's agricultural and business leaders.

Washington, Oregon, Idaho, Montana, and even British Columbia, were among the areas represented in the first two Northwest workshops. The groups included teachers in all grades, county superintendents, principals and special teachers, taking part as delegates appointed by the schools they represented. After the workshops were over, they returned to their home schools and presented the carefully worked-out curriculum plans and suggestions to the various school groups concerned, for their final criticism and use.

The workshop plan differs from the usual method of conducting a school, in that there is a minimum of lecture work and a maximum of guidance of working groups or committees. In short, it is the laboratory method of curriculum building instead of the old lecture and assignment method. At Reed College, for example, there were seven such committees, each with a leader—science, languages and arts, social studies, Northwest resources, the elementary field, guidance, and materials.

Representatives of different State, Federal and other agencies dealing with natural resources were called by the workshops for consultation—this on the theory that even though many studies containing a wealth of information have been made by these information sources, they have not been widely read in the past. In addition to land resources, the first summer's

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curriculum studies included forestry, fisheries, minerals, water, industry, power, population, and culture, from both a regional and a national point of view.

Dr. Edgar M. Draper, head of the department of education at the University of Washington, was in charge of the workshop at Seattle. The Reed College workshop at Portland was directed by Virgil W. Smith, principal of the Seattle schools. Dr. Draper defined the workshop movement in this way:

"The workshop is an attempt to tie up the curriculum with practical undertakings and technical services. It is our intent to vitalize our courses by taking out some of the dead wood and putting in living phases of the country's activities, based on actual resources."

The Soil Conservation Service took active part during the summer in response to requests to present soil conservation information to seven college summer-school institute groups. Similar but less intensive consideration was given this and allied natural resources subjects by the several hundred teachers and educators attending. The 2- and 3-day institutes were at the University of Idaho, Moscow; State College of Washington, Pullman; Eastern Washington College of Education, Cheney; Central Washington College of Education, Ellensburg; Western Washington College of Education, Bellingham; University of Oregon, Eugene; and Oregon State College, Corvallis.

CURRICULUM AND SOIL CONSERVATION

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perhaps this probably is sufficient to enable the reader to grasp the meaning and nature of the experiment that has been in progress.

The attention of the Nation is now focussed on national defense. We have firmly rededicated ourselves to the problem of preserving, for ourselves and posterity, the heritage of democracy. We should not lose sight of the fact that the roots of democracy are in the soil; and that the spiritual strength of a strong agrarian commonwealth will ensure us our democracy. To safeguard for the Nation a hardy rural life, and hence democracy, education must devote itself increasingly to the development of the rural community. Curricular materials must not educate the child entirely away from his environment, but must prepare a fair percentage of rural youth for rural living.

General trends of the curriculums of our schools, from the grade school through college, can be advantageous or dangerous to our national welfare and will affect democracy correspondingly. Any curriculum that fails to develop love of home, love of farm or

village or community, and which largely develops dissatisfaction with the home environment, is dangerous to national welfare.

The only really scientific measurement of the curriculum is time. Such a measurement is a matter that concerns each individual citizen in a democracy. The effectiveness of the curriculums in the development of rural life during the past 20 years cannot be discussed here. However, it may be of interest to readers of this article to know that patrons who have read such of our bulletins as *The New School* and *Its Teacher*, *Experimenting With Soils*, and *Youth and the Soil*, compiled and published cooperatively by our college, the Soil Conservation Service, and the North Dakota Extension Service, have told us that these are the subjects they have wanted in their schools for years but have been unable to attain. Perhaps we should remember that in a democracy, in the final analysis, those who support the schools are entitled to have, and will have, that which they desire.

TAR HOLLOW LABORATORY

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A functional approach was made to the landscape and its land-use and social and economic problems. Some of the teacher-trainees possessed a science background, but among the 50 or more in attendance were kindergarten teachers and public-school nurses. These people could learn and enjoy their experience because the aim was an understanding of the interrelation of soils, plants, animals, man, and environment.

How far-reaching was this school? What dividends will it pay?

If you ask the teachers themselves, not one will deny that he is better prepared to explain the intricate relationships involved in any program of conservation—whether, next September, his pupils are first-graders or high-school seniors. These teachers saw things and learned to understand things that they have been stepping on all their lives, without ever seeing.

Instead of 50 more people who now have a better understanding of conservation, we shall have a thousand because each teacher will reach a score of youngsters, and then another score, and then another. The program is a practical, educational-demonstrational program for farmers, bolstered by technical research. But it is more. It must be a public-education program, so that the merchant, the banker, and the manufacturer all learn the meaning of soil conservation. One of the quickest ways to achieve this goal is to teach the banker's little girl and the manufacturer's growing son.



Panel discussion, University of Georgia. Technicians and trainees replan a farm. (Inset) Studying a steep area, now cultivated, that should be retired to perennial vegetation for hay.

A NEW APPROACH TO TRAINING LEADERS IN FARM PLANNING

By O. C. ADERHOLD ¹

“I BELIEVE that the new approach to training leaders in farm planning inaugurated in this State is the beginning of a new procedure that will be most effective in coordinating the activities of agricultural education and will be used as a permanent and State-wide policy,” said Paul W. Chapman, dean of the College of Agriculture of the University of Georgia. Dean Chapman made the above statement at the conclusion of a special course in farm planning designed to meet the needs of teachers of vocational agriculture, county agents, and Soil Conservation Service technicians.

One of the most important problems facing all workers in the field of agriculture is that of helping farmers to do a sound job of farm planning. Since more than one agricultural agency may work with the individual farmer and the farmer group, it is essential that the efforts of all agencies be coordinated in order

to prevent overlapping of effort and useless duplication; but more important, it is essential that the efforts of these several agencies result in helping the farmer in formulating a better and sounder farm plan. The coming of the national soil conservation program has placed emphasis upon the need for better-trained personnel and the need for coordinated effort in helping farmers to replan their farms.

In Georgia the Agricultural Extension Service, the Division of Vocational Education, State Department of Education, and the Soil Conservation Service have been requested by the supervisors of the several soil conservation districts in the State to participate in a program of formulating farm plans with special reference to the conservation of soil and water. Since a cooperative plan has been developed which makes it possible for county agents, teachers of vocational agriculture, soil conservation technicians and others to work together in helping farmers to set up farming programs, it is necessary that workers in these fields

¹ Professor of vocational education, College of Education, University of Georgia, Athens, Ga.

have specific training in the abilities necessary to assist at certain places and in certain ways in the formulation of these programs. The points of cooperation are specifically stated in the work plan of these several districts.

One of the specific problems that county agents, teachers of vocational agriculture, and soil conservation technicians have agreed they will help the farmer to solve is that of setting up his program in the light of the human, soil, and other natural resources on the farm. If these workers are to help the farmer in this direction they need specific preparation to do the job.

In view of the above needs, the Agricultural Extension Service, the Division of Vocational Education, State Department of Education, and the Soil Conservation Service have requested the Division of Teacher-Training in Vocational Education, College of Education, to organize, through the College of Agriculture of the University, a course to develop the needed abilities on the part of the agricultural workers in these three fields. The training program outlined below has been developed.

Training Plan

The college of agriculture made available its entire technical staff, and in cooperation with experts in the Soil Conservation Service, the school of forestry of the university, the Extension Service, State experiment stations, the State forestry service, the Farm Security Administration, vocational education leaders, and the Agricultural Adjustment Administration, is providing technical service for the training course.

The college of agriculture provides:

a. Instructors to teach county agents, teachers of agriculture, and soil conservation technicians to understand and interpret basic farm data. Approximately 1 day is spent with the trainees in the soil conservation district, or in a specified area, in analyzing and interpreting the social, economic, and farm data on two selected farms. The farm management and soils specialists give instructions to the workers in dealing with these basic data.

b. A staff of specialists in the several fields of agriculture to participate in a panel and to assist in formulating two farm programs. Approximately 1 day is devoted to the planning of each farm. The panel procedure is used and trainees are allowed to participate freely in the discussion. The first purpose of the panel is to bring the workers up to date in all fields of agricultural information and to use these data in making specific farm plans. In other words, it is the purpose here to integrate the best information from

the fields of agricultural knowledge into the planning of specific farm programs. The second purpose is to demonstrate an educational method that may be used by agricultural workers in cooperation with technicians, local experts, and selected farmers in a community in planning farm programs.

c. A teaching staff composed of the following specialists:

1. Animal Husbandry:
 - M. P. Jarnagin, head of the department of animal husbandry, University of Georgia.
 - B. L. Southwell, State experiment station, Tifton, Ga.
2. Agricultural Engineering:
 - J. D. Clement, area agricultural engineer, Soil Conservation Service.
 - W. E. Hudson, instructor in agricultural engineering, University of Georgia.
3. Soils:
 - W. O. Collins, acting head of the department of agronomy and professor of soils, University of Georgia.
 - C. B. Gay, area soil technician, Soil Conservation Service.
4. Crops:
 - J. E. Pollock, area agronomist, Soil Conservation Service.
 - C. C. Murray, assistant professor of agronomy, University of Georgia.
 - E. D. Alexander, agronomist, Agricultural Extension Service, Athens, Ga.
 - George W. Dickinson, regional officer, Soil Conservation Service.
5. Farm Management:
 - J. W. Firor, head of the department of agricultural economics and rural sociology, University of Georgia.
 - Frank P. King, associate professor of agricultural economics and rural sociology, University of Georgia.
 - J. W. Fanning, Agricultural Extension Service, Athens, Ga.
 - A. O. Duncan, College of Education, Athens, Ga.
6. Forestry:
 - A. D. McKellar, assistant professor of forestry, University of Georgia.
 - C. B. Beale, area forester, Soil Conservation Service.
7. Horticulture:
 - T. H. McHatton, head of the horticultural department, University of Georgia.
8. Poultry:
 - J. C. Bell, assistant professor of poultry husbandry, University of Georgia.
9. Homemaking:
 - Alice Beall, associate professor of home economics education, University of Georgia.
 - Susan Mathews, home economist, Agricultural Extension Service, Athens, Ga.
10. Conservationist:
 - R. L. Dolvin, Soil Conservation Service, Athens, Ga.
11. Agricultural Adjustment Administration:
 - R. R. Childs, assistant field officer, A. A. A.
12. Farmer:
 - C. E. Fleeman, Jr.
 - Director of the Course:
 - O. C. Aderhold, professor of vocational education, College of Education, University of Georgia, Athens, Ga.

Procedure

The many people involved in the undertaking made it necessary to develop a definite plan of procedure. Below is an example of the procedure for one of the in-service training programs:

1. Representatives of the Agricultural Extension Service, Division of Vocational Education, and the Soil Conservation Service in cooperation with certain county agents, teachers of agriculture, and technicians selected the two farms to be studied and replanned in the training course.

2. The Soil Conservation Service provided comprehensive data on the soil and other resources on the selected farms. They made a soils-resource map for each of the farms and provided copies of these maps for all the members of the faculty and trainees in the course. The maps show soil type, percent of slope, degree of erosion, and land use.

3. Selected teachers of agriculture procured the social and economic data on the two farms, and the Division of Vocational Education duplicated these surveys and provided each member of the staff and each trainee with a copy. The surveys provided data about the family, the home, general farm information, scope and production and value of enterprises, crop and livestock practices, farm expenses, and financial statement.

4. The members of the staff visited each of the selected farms and, with the soils, economic, and social data in hand, studied the farms first-hand.

5. Copies of the social and economic data, along with the soils map, were placed in the hands of all trainees, and the two farms were visited and studied. Approximately one-half day was spent on each farm.

6. The farm-management instructor met with the trainees and together they spent a minimum of one-half day studying the economic and social data gathered from the selected farms.

7. The soils specialist spent a minimum of one-half day with the trainees studying the soils and other natural resources of the selected farms—reading maps, field lay-out, etc.

8. The entire staff and the farmer assembled and, through the use of the panel and conference procedure, replanned each of the farms. Approximately 1 day was devoted to setting up a plan for each of the farms. The panel procedure was to take the aspects of farm planning as listed below and through discussions to find a solution for each of the problems. The solution found was the result of careful consideration and evaluation of facts and opinions presented by the members of the staff and the farmer. In most

instances the group reached a unanimous decision about the several aspects of the farm plan. The following general procedure was used in setting up each of the farms:

- a. Setting up the type of farming for the farm.
- b. Setting up the food and feed program for the farm.
- c. Setting up the livestock program on the farm.
- d. Setting up the cropping program on the farm.
- e. Setting up the forestry program on the farm.
- f. Setting up a wildlife program on the farm.
- g. Setting up a rotation system to practice on the farm.
- h. Setting up a water-disposal system for the farm.
- i. Setting up certain farm practices such as:
 - (1) Terracing practice.
 - (2) Meadow stripping.
 - (3) Sanitation practices.
 - (4) Home conveniences.
 - (5) Others.

9. The soil conservationist spent a minimum of one-half day with the trainees in writing up plans and agreements for the replanned farms. These agreements are in line with the basic requirements of the work plan for the district.

10. The technical staff of the Soil Conservation Service directed the trainees in a comprehensive study of the soil-conservation practices now being carried out on certain soil-conservation demonstration areas. Two days were devoted to a study of these practices.

11. Representatives of the Agricultural Extension Service, of Vocational Education, and of the Soil Conservation Service spent a minimum of one-half day with the trainees in planning methods and techniques for giving instruction to individual farmers and to groups of farmers in farm planning.

Results of Training Course

The training program for in-service groups has reached approximately three-fifths of the teachers of vocational agriculture in the State and many county agents and soil technicians. The teachers working with the Soil Conservation Service have made real progress in farm planning. For example, during the first 6 months following a training course in the Broad River area the teachers planned 132 farms or an average of over 5 farms per teacher. Each of these farm plans is for 5 years and involves many changes in farm practice and farm organization.

A member of the Soil Conservation Service said: "We have real soil conservation programs going in counties where representatives of all three agencies have participated in the training course."

Pre-Service Training Program

If training to deal with this special problem of farm planning is necessary for in-service workers in agriculture, it is even more necessary that such a training

program be provided for pre-service agricultural workers. Those responsible for training teachers of vocational agriculture in Georgia have through the College of Agriculture provided such a training program for pre-service teachers.

The training program for prospective teachers is essentially the same as for the in-service group. The major differences are:

1. The courses are planned specifically for prospective teachers of agriculture; the in-service courses are planned for teachers, county agents, and soil technicians.

2. The staff is largely composed of members of the faculty of the College of Agriculture.

3. The group of prospective teachers participates in the planning of only one farm, whereas the in-service groups plan from two to four farms.

4. The follow-up work with trainees in new practices such as strip cropping is done by members of the college staff, whereas for the in-service group this is done by the Soil Conservation Service.

The reaction of the technical staff and the trainees

to both the pre-service and in-service training programs may be garnered from the following statements:

One of the teachers of vocational agriculture said at the conclusion of the course: "This course has done two things for me. It has brought me up-to-date in technical agricultural information and has shown me how to use all of my technical knowledge in helping farmers in farm planning."

The members of the college faculty and technical staff expressed themselves as delighted with the opportunity of working with other technicians in planning the farms. Dr. Jarnagin, of the Animal Husbandry Department, said: "I feel that this type of a course is not only excellent training for teachers of agriculture but would be equally valuable for all the seniors in the College of Agriculture. This project has brought to our attention the abilities needed by teachers of vocational agriculture, county agents, and soil technicians and will enable all of us to make our courses more functional for these men. It has helped the college staff as much as it has the people enrolled in the course."

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CONGRESS HEIGHTS SCHOOL ACTIVITIES—See Opposite Page.

1. *A baking pan and clay were used by a sixth-grade group to make this model showing mountain formation and strata of the earth. The interest in earth formation came from a visit to a new road cut.*

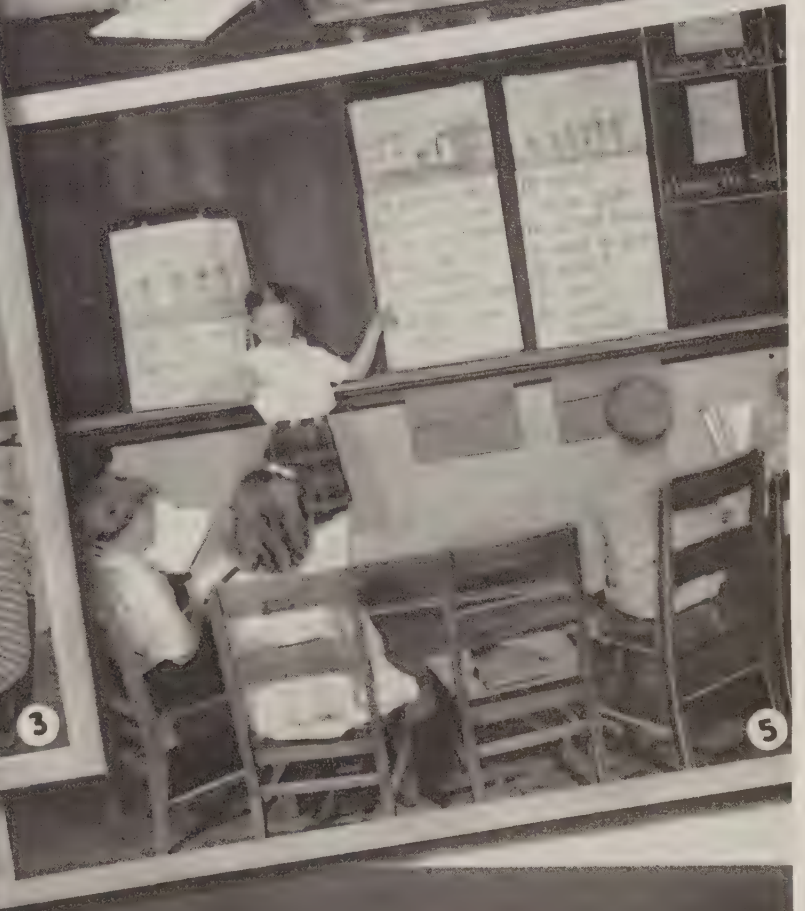
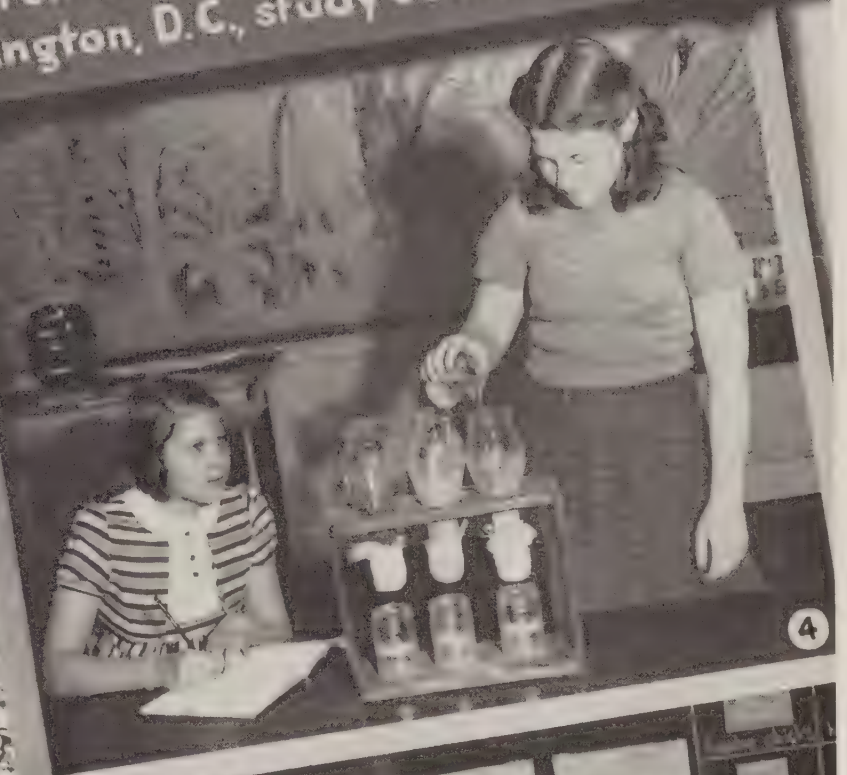
2. *Growing on this rock were found lichens, mosses, and ferns. From the work done in classes these girls were able to read a very interesting story.*

3. *Samples of soil being tested for acidity, air in soil, and the feel of soil left in an open container compared with that kept in a closed container.*

4. *Three lamp chimneys, sand, clay, and garden soil were used by a sixth-grade group to study how rain penetrates different soils.*

5. *First-grade experiments with soil were the basis of this reading work. The teacher planned a series of stories and games for her class, duplicated them, and put them together in a book.*

Children of Congress Heights School,
Washington, D.C., study Soil Conservation.



CHENEY LABORATORY SCHOOL

By FRANK B. HARPER ¹



Most children like machinery. Martin Mickey holds their interest in explaining how implements on his farm till the soil in such a way as to leave a cover of straw and stubble for protection of the field from wind and water erosion.

THE study of the soil, its waste and conservation—land use—was added to the curriculum of the Eastern Washington College of Education laboratory school at Cheney for the first time last year. It came about when Dr. Otis Freeman, head, department of science, suggested to Director Clark M. Frasier and the laboratory school staff that resource teaching be developed in connection with regular class work. They did so and obtained technical and teacher-aid material from the Soil Conservation Service through its Region 9 office at Spokane, 17 miles away.

A definite project for the 1939-40 school year promptly was set up, with the conservation subjects added to the curricula of the first six grades as part of the pupils' home relation work. The task was not at all difficult; it was found that the study of soil followed logically in subject matter already taught. For example, the first-graders' nature study suggested the dependence of the birds, flowers, and trees upon the soil. The second-graders had been studying about food and clothing; it was but a short step to tie up the origins of these essentials in the soil. In the third

grade, shelter as the base subject carried smoothly over into houses, trees, and forests, and the soil from which trees grow.

From the picture scrapbooks, made up by the little folks, to the popular and even technical bulletins on soil conservation read by the older pupils, soil conservation was found to fit naturally into the laboratory school courses all along the line. New subjects were at hand for coloring and painting, furrows and contour crop strips to reproduce in the art room with crayon and brush, new words for vocabulary studies—erosion, contour, trashy fallow, and so on. A large water-color mural on soil conservation, painted as a class project by fourth-grade pupils, was an outstanding school production of the year.

Grass clumps and soil samples, studied with great interest in the schoolroom, were made to mean more on the field trips arranged that children might see how grass roots bind the soil and how soil washes and blows away when it has no roots to hold it. Out on the farm, the pupils saw gullies, and fields tilled with the slope and across it. Back in the schoolroom, they wrote about what they saw, drew pictures, and built simple models of the "right" and "wrong" way of farming.

Cheney is at the eastern end of what is known as the Big Bend country, one of the major wheat-growing areas of the Pacific Northwest. The laboratory school's pupils come from the farms and ranches of the area, as well as from the families of townspeople depending upon the Big Bend's agricultural bounties. Director Frasier knows that within a few years these young people will be doing the farming themselves, or will be carrying on business with their former schoolmates who are raising the wheat and the cattle and sheep. Many of tomorrow's Big Bend men and women will know about soil erosion and how to prevent the losses of unwise land use.

Approximately 300 pupils studied about soil conservation last year, and carried many of the lessons they learned back home to their parents and acquaintances.

The city schools of Memphis, Tenn., are proving that even among city children a knowledge and appreciation of conservation problems and a more desirable attitude toward these problems can be created.

¹ Regional division of information, Pacific Northwest Region, Soil Conservation Service, Spokane, Wash.

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Compiled by **ETTA G. ROGERS, Publications Unit**



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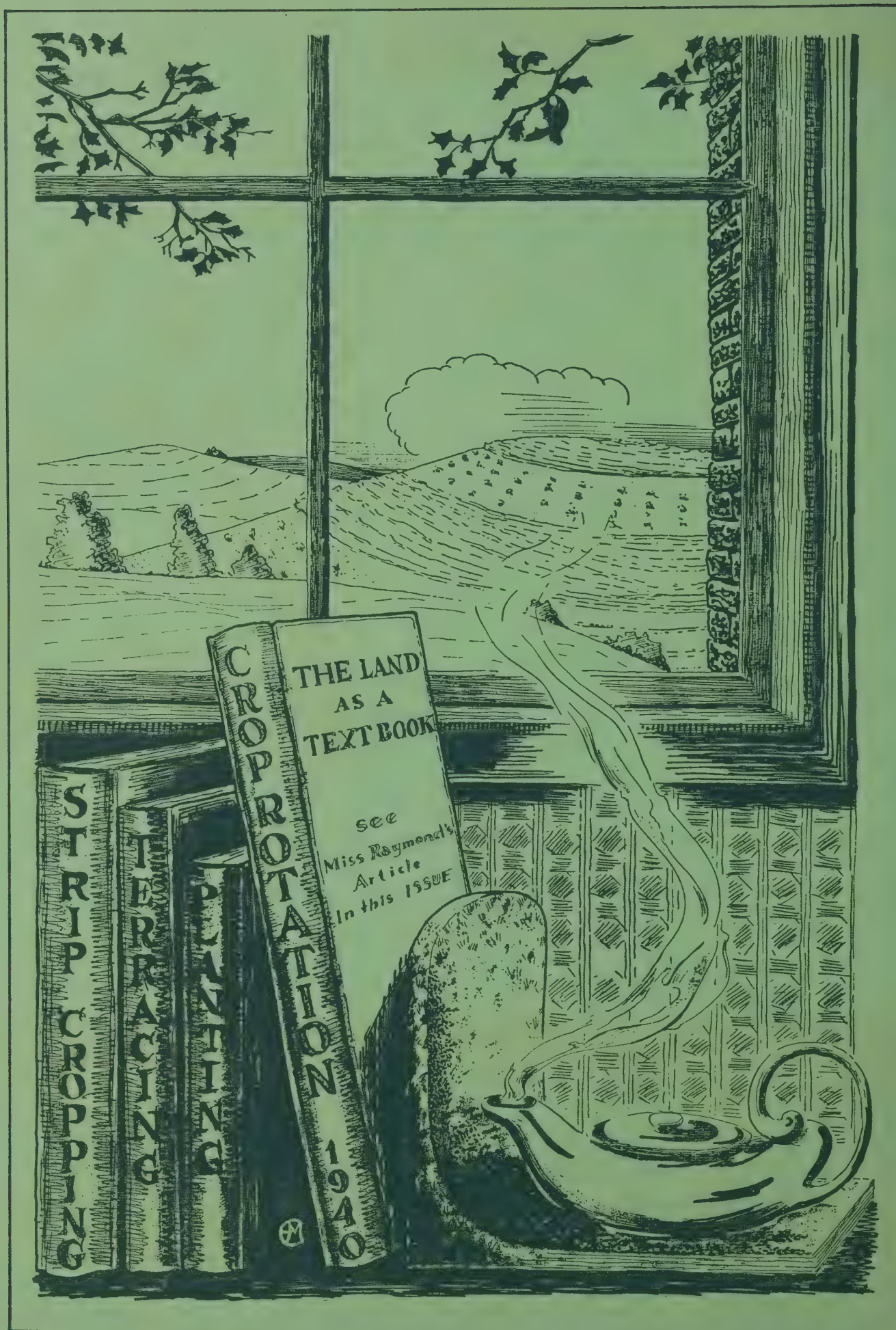
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NOVEMBER 1940

Leading Articles



NATIONAL DEFENSE AND
THE C. C. C.

THIRTY YEARS OF VERTICAL
FARMING

ECOLOGY AND LAND USE



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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WELLINGTON BRINK
EDITOR

SOIL CONSERVATION is issued monthly by SOIL CONSERVATION SERVICE of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by direction of the Secretary of Agriculture as administrative information required for proper transaction of the public business, with the approval of the Director of the Budget. SOIL CONSERVATION seeks to supply to workers of the Department of Agriculture engaged in soil conservation activities, information of special help to them in the performance of their duties. Copies may also be obtained from the Superintendent of Documents, Government Printing Office; Washington, D. C., 10 cents a copy, or by subscription at the rate of \$1.00 per year, domestic, \$1.50 per year, foreign. Postage stamps will not be accepted in payment.



Much destructive water comes down from the upper field, when potato rows continue to be run down the slope. This farm near Presque Isle, Maine, has been used for decades, principally for the production of potatoes. The soil has been thinned down so much that bedrock is exposed in many of the washes that have dissected it. Terrace channels had to be blasted through rock in many places to get adequate depth.

THIRTY YEARS OF VERTICAL FARMING

BY H. H. BENNETT ¹

SOME thirty years ago, I went into northern Maine on a hunting expedition. To be precise, it was 32 years ago and the hunting was of a technical nature—the searching out of the soil characteristics in the Aroostook potato district, the classification of the soils occurring in that part of the United States, and an appraisal of their productivity and agricultural adaptation.

By horse-and-buggy we explored back and forth through the 339,200 acres of land covered by the soil survey of the “Caribou Area,”² lying in northeastern Aroostook County. We dug into the soils of fields, meadows, forests, and muck bogs; we measured the depth of the material and recorded the characteristics of the different layers occurring at different levels through the profile. Twelve soil types were mapped. The most important one was that ideal potato soil, the Caribou loam—220,000 acres of which were found within the area surveyed. The upland soils, formed of glacial material, largely of limestone origin, were found to be for the most part splendidly adapted to potatoes, as well as to clover, grass, oats, and other crops amenable to the climatic vicissitudes of 46°20' north latitude.

At that time much of the cultivated land was newly cleared of its rich forest cover; nearly all of it was new land. The content of organic matter was high, and the better cropland such as the Caribou loam was deep, mellow, and highly productive. An important agriculture had been established—this Aroostook area represented then as it does now one of the most important potato producing districts of the Nation. Excellent yields were being produced; but even then farmers here and there were getting away from some of the fundamentals of the older agriculture which included such activities as dairying, the production of beef and mutton, and the growing of clover and timothy. Large quantities of timothy hay were shipped to Boston. The change that was setting in at that time was in the direction of more potatoes and less grass—and, incidentally, more erosion and

¹ Chief, Soil Conservation Service, Washington, D. C.

² Published by the Department of Agriculture, 1910.



Erosion on Presque Isle farm where buckwheat was used as a green manure crop. Deposits of coarse material cover good land along the lower slope. The rich, fine soil has floated along toward the Atlantic.

less potatoes per acre on too many acres, with no potatoes on some acres.

What I particularly want to stress now, however, is the fact that in this Maine area we found, nearly a third of a century ago, productive land that did not show enough erosion to arouse any suspicion of its importance as a farm problem. Certainly, there were no gullies and in the average field sheet erosion had not proceeded far enough to expose the lighter-colored, yellow subsoil. In general, agriculture was flourishing. On the farm, the past—part of it at any rate—had been very good; the present was prosperous; the future looked rosy. But even then man was bending nature's way of doing things—thoughtlessly, but none-the-less violently. Nature had established no straight-line, downhill waterways for disposing of surplus rainfall and melting snow. The streams that nature had built followed winding courses by moderate gradients; the virgin land was covered with vegetation so as to distribute rainfall evenly over the surface of the ground and otherwise prevent its rapid run-off.

At that time physicists knew about a number of laws that nature had set up governing the flow of water. It was known, for example, that water would not flow uphill, that it flows faster as the volume within an open channel increases, and that the faster it flows the greater the load of material,

such as productive topsoil, it can carry away in suspension. And so, even good farmers, who practiced good crop rotations and employed other scientific methods of farming, openly and unknowingly violated the laws of gravity and hydraulics, and forthwith ran their potato rows and all other kinds of rows straight down the hill.

On this second trip, in September 1940, good potatoes—great quantities of them—were still being grown in the Aroostook district, but unfortunately, the farmers were expecting low prices for the year's crop. I learned of predictions of prices so low as not to pay the cost of production.

There had been an unfavorable change in the price of potatoes since my first visit. I was told that this change was an economic change, and I could find no argument with that view. Thirty cents or less for a whole bushel of beautiful Aroostook County potatoes, as some feared the price might be, was not much, certainly.

I had heard before arriving that the land had undergone certain "physical" changes, especially the washing off of the mellow topsoil to stiffer subsoil which was less retentive of rainfall, more difficult to plow, and less productive. But I hadn't counted on any such prodigious change in the soil as I actually found—change caused by erosion. And let it be added here as specifically as possible that the general result of this physical

effect of erosion was having a critical economic effect on farmers by way of such unfavorable economic items as reduced productivity of the soil, increased cost of filling gullies so that "farm machinery can get across the ditches," abandonment of fields in which the soil had become too stony (as the result of the assorting effect of erosion) or too shallow for cultivation, etc., etc.

Still I found that some things had not changed. Most of the steep cultivated slopes had yellow subsoil at the surface or near the surface; some of them showed gullies—one a short distance north of Presque Isle was 10 feet deep and it might have been deeper but for the fact that it had cut down to solid rock. The exposed subsoil, the reduced



Little erosion can take place in this Aroostook County potato field so long as the ground is covered with clover and grain stubble like this. Where potatoes are grown on sloping land, they should be on the contour with strips of protective crops between, or terraces where needed. Rotations should include soil-building and soil-holding crops like clover, alfalfa, and grass.

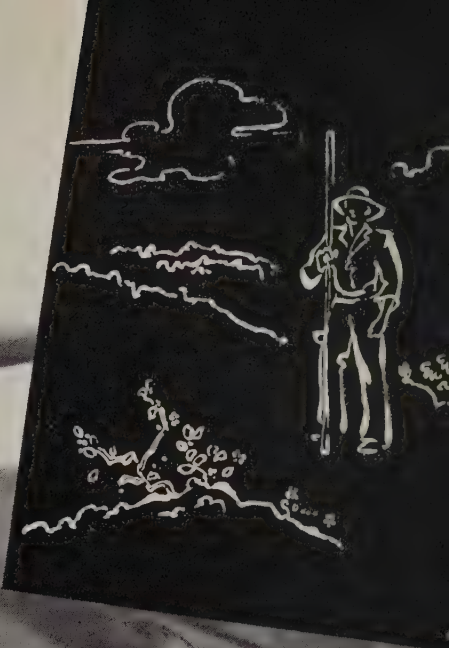
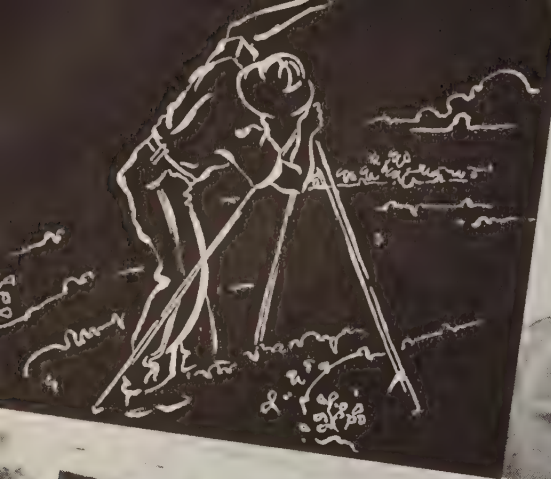


Soil erosion, spring of 1936, caused by melting snow. Aroostook County, Maine.

content of soil humus, had increased erodibility of the land and the tendency of the soil to bake. Some fields abandoned to grass contained very little grass; there were more weeds than grass, and the soil was dry and hard and resistant to penetration by rainfall. There was a tone of uncertainty about the farm outlook on the part of some of the local people with whom I talked. It was costing a lot of money to grow potatoes, I was told. "Our land is not all as good as it used to be." Another observed: "You know one of our oldest and reputedly best farmers found out only this year that one of his best potato fields is suffering severely from erosion. He thinks all the washing resulted from this year's rains, but, of course, it is the accumulated result of 30 years of cultivation, most of the time to potatoes."

I was going to point out some of the things that had not changed across the interval of a third of a century between my trips to this part of Maine. One thing that hadn't changed was the direction of potato rows. Most of them, except on farms that had cooperated in the Soil Conservation Service demonstration project, still ran straight down the hill. The natural law with respect to the scouring capacity of water flowing in open channels downhill—I mean, in this instance, the furrows between potato rows—had not changed, nor had it been amended in any particular. The effects were distressing, even those caused by the rains and melting

(Continued on page 122)



TRAINING

FOR THE PRESENT
AND THE FUTURE



SOIL CONSERVATION



CLAUDE R. WICKARD
Secretary of Agriculture

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NATIONAL DEFENSE AND THE C. C. C.

BY H. D. ABBOT ¹

ENROLLEES in the 392 Civilian Conservation Corps camps operating under the direction of the Soil Conservation Service are securing training and experience in many semiprofessional skills that are valuable to the defense program.

While all the 78,000 enrollees now working with the Service have received some background having defense value, 25,000 of them have had both instruction and on-the-job experience in special skills, such as truck driving, mapping, mechanics, construction work, or many others. The same is true of many thousands of ex-enrollees who have returned to their homes after serving enrollment periods.

¹ Assistant to the Chief, in charge of C. C. C. operations, Soil Conservation Service, Washington, D. C.

Emphasized in the pictures on the opposite page is the purpose of C. C. C. training, which is to make the enrollee an efficient workman and to help him become a more useful citizen.

1. Operating terracers, tractors, trucks and other heavy equipment gives specialized experience. Many enrollees become better fitted for jobs in private industry.

2. Vaccination comes early in camp life. Wholesome food, outdoor life, regular hours, and medical care make sound, strong bodies.

3. Mechanics, welding, blacksmithing, surveying, and other occupational trades are taught. Natural aptitudes are given consideration.

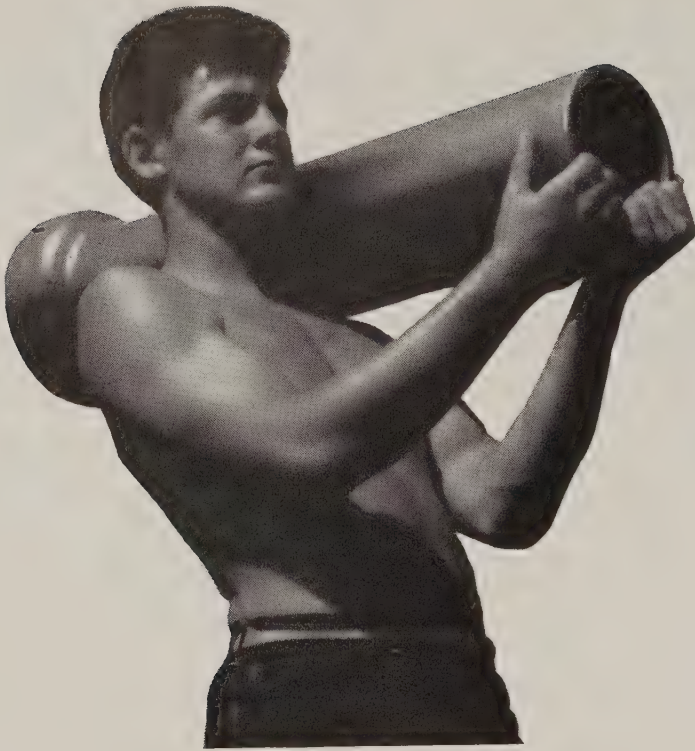
4. Many enrollees are from farms. They take home, and directly apply, what they learn in soil conservation.

5. Camp office work provides clerical training. Many enrollees become draftsmen and mappers; others, cooks and bakers.

Leaders and assistant leaders have learned to "handle" men, a skill which must be developed by those who wish to qualify as non-commissioned officers in the military service. The enrollees have learned to live and work together; they have learned the value and effectiveness of team-work, the necessity for and means of maintaining proper sanitation, and how to carry on construction with safety both to themselves and their co-workers. Through daily exercise, regular hours of sleep, and well-balanced diets, they are physically fit. These basic assets for national defense have all been acquired while carrying out what is in itself a fundamental national defense program—the conservation of our most essential resource, the soil.

Referring to the program during its first 7 years, J. J. McEntee, Director of the C. C. C., lists three major ways in which the Corps contributes to the defense program. First, there is the continuation and intensification of the program for building up the health, the physical strength, the morale, the general education and the civic usefulness of its young men. The second comes through the broad training and educational programs which instruct enrollees in proper work habits and discipline, and in skills useful in national defense as well as in industry. Third, and not the least important to national defense, is the contribution the C. C. C. enrollees are making to the various programs furthering the conservation of our national resources.

The Nation was shocked to learn of the poor physical condition of men called to the colors during the World War; equipping them physically so that they were able to become good soldiers took valuable time from military training. The C. C. C. faced similar problems. Many enrollees came to the Corps under-



Hard muscled and forward looking.

nourished and under-sized, and they had to be worked into the field programs on jobs they were physically capable of handling. A health survey of the C. C. C. by the Office of the Surgeon General of the Army, showed that normal weight expectations were not met by 25 percent of the enrollees. The same report shows that upon completion of the enrollment periods all but 4 percent had advanced beyond the minimum weight specifications.

Compulsory vaccinations for typhoid and smallpox have enabled over two million C. C. C.-trained youths to return to their communities protected against these dread diseases. Voluntary vaccinations for pneumonia begun in October 1937 at the suggestion of Johns Hopkins University, have been given to over 40 percent of the enrollees. Tuberculosis incidence in the C. C. C. is about one case per thousand, far below the expectancy for a comparable age group. Venereal disease frequency is exceptionally low. Teeth and eyesight of the C. C. C. boys are given both attention and care, with direct benefit to the general health and well-being of the individual.

From the standpoint of health alone, two million youths who thus far have served in the C. C. C. are in much better physical condition to carry out their share of defense service than are the average for their age group.

It is usual for laymen to think of military operations only from the standpoint of the fighting personnel, but any military technician will declare that it is equally important to have ready a highly integrated,

trained civilian army to help service the armed forces in connection with food, equipment, communications and other facilities. At the present time and not counting the far greater number who received training in the first 6 years of the C. C. C., the 392 camps of the Soil Conservation Service, or only about 25 percent of the 1,500 C. C. C. camps, have in active service each day some 78,000 enrollees being fitted by work experience to take their place in this civilian army should the occasion arise. About one-third of these have voluntarily taken advantage of the opportunity for special training, both on and off the job, to prepare themselves to serve as repair men, surveyors, clerks, orderlies, draftsmen, blacksmiths, cooks, bakers, and many other types of specialists needed in the national defense program.

The training is not limited to mere theoretical instruction. It goes beyond theory. The task of the C. C. C. is to perform work, and advantage is taken to a high degree of the opportunity for on-the-job training, to learn by doing, in the training work. Theoretical principles are explained as a means of enabling the enrollee to work more efficiently and to understand more clearly the relationship of any momentary function to its associated operation. A considerable number of the C. C. C. boys go beyond instruction given in camps and enroll in correspondence courses given by colleges and private institutions, or attend night schools located in towns near camps.

Analysis of jobs performed by C. C. C. enrollees shows that they cover a field of 323 types of work, 262 of which are useful in national defense. The work programs in soil conservation camps offer opportunity for training in the more important of these work types—excavation, earth moving, road building, dam construction, the use of surveying instruments, mapping, use of explosives, clerical duties, equipment and tool operation, maintenance, and repair, as well as a host of other types of work required by defense activities. All leaders, assistant leaders and truck drivers are required to pass the American Red Cross Safety Course, knowledge of considerable worth from the point of view of national defense.

The accomplishments of the C. C. C. in furthering the program of soil and moisture conservation have been many and varied. Hundreds of thousands of check dams, thousands of terrace structures, thousands of miles of relocated fences, and innumerable other control measures have been constructed by the enrollees in benefiting some 12,000,000 acres of land. This work has a very real bearing on sound land use and the task of feeding troops and the civilian work army.

Direct benefits will result from the methods of more efficient crop production due to better land use and the elimination of farming practices which allowed unnecessary loss of the topsoil by erosion. The realization, which the demonstration of erosion control drove home, of how the large areas uncovered during the World War later brought dust storms and floods, with accompanying agricultural and social problems, may well be a major future benefit from the Nation-wide erosion control program with which the C. C. C. has assisted.

As a group, the 300,000 enrollees in camps of the Civilian Conservation Corps provide a formidable source of trained young men. Sixty-three central repair shops will be in operation this fall, and it is estimated that, by rotating enrollees, some 2,000 per year can receive high-quality automotive mechanical experience. In addition, by shifting boys assigned to the 1,500 camp garages, between 7,500 and 9,000 will learn the fundamentals of automotive maintenance. The latter group is, of course, in addition to 67,000 youths who, as operators of the 43,000 pieces of motorized equipment, help to keep their machines in running order.

The Army participates in the C. C. C. training program and its cooking and baking school prepares about 6,000 enrollees every 6 months for camp duty as cooks, bakers, butchers, mess stewards, and assistants. Approximately 2,500 enrollees serve as medi-

cal orderlies in camps and hospitals. During the last fiscal year, 50,000 leaders, assistant leaders, and truck drivers completed the regular first-aid course of the American Red Cross.

In the field, some of the roughest terrain in the Nation has been crossed in building over 114,000 miles of fire roads and trails, and in installing about 79,000 miles of telephone lines. The Corps has constructed over 7,000 horse bridges and some 36,000 vehicle bridges.

It is safe to assert that in the field work of the C. C. C. every enrollee has received some training of benefit to a program of national defense. The training in special skills, while it has been voluntary except for enrollees engaged in tasks requiring special basic preparation, has further prepared many thousands for effective service. By recent action the Congress authorized the President, in his discretion, and under such regulations as he may prescribe, to provide within the Civilian Conservation Corps such training of enrollees in noncombatant subjects essential to the operations of the military and naval establishments as he considers may contribute materially to the interests of the national defense. This action makes it possible for the Nation, at such time and in such manner as the President may decide, to utilize further the opportunities inherently present in the C. C. C. program for training in national defense.

TO PROMOTE THE GENERAL WELFARE

BY THE DIRECTORS OF THE SHILOH-O'FALLON (ILLINOIS)

SOIL CONSERVATION DISTRICT¹

WE, THE directors of the Shiloh-O'Fallon Soil Conservation District, believe that conservation of the soil is essential to promote the general welfare of ourselves and our posterity. We believe that organization of districts offers to farmers an effective medium for solving their problems of erosion control and land use.

Farmers in Shiloh and O'Fallon townships in St. Clair County, Ill., were not long in organizing a soil conservation district after the Illinois district law was passed in 1937. The Shiloh-O'Fallon district was the first to be organized under the law.

In the 1½ years since the district started operation, landowners in three adjacent areas have voted that their land be included through the same procedure

used in forming the original district. The first addition, in July 1939, was 29,000 acres; the second, in January 1940, consisted of 2,500 acres; and the third addition, in May 1940, included 20,000 acres. The size of the district has thus been increased from 18,000 acres to about 70,000 acres; and the number of farms it includes has increased from approximately 200 to about 650.

St. Clair County, in which Shiloh-O'Fallon district lies, is the oldest county in the State, organized in 1790 and fixed at its present boundaries in 1825. In about a hundred years of farming, 50 percent of the land has lost over half of its topsoil.

The erosion problem is serious, though not so evident to the eye. The topography is generally rolling; about half the land is above 7 percent in slope. Gullies of all sizes are easy to find, but they do

¹ Theodore E. Reuss, Chairman, Fred Bergmann, H. J. Bechtloff, Walter Luckner, Walter J. Mueller.

not account for nearly as much of the soil losses as sheet erosion does. The financial condition of the county is fairly good, there is no tax delinquency.

Over the county, farmers were not fully aware of the extent of erosion damage. The Extension Service had been emphasizing the erosion problem, and soil conservation demonstrations were only about 20 miles away at the soil conservation project near Edwardsville. But most farmers had too little knowledge of how badly erosion was depleting their own farms.

The establishment of the soil conservation district brought the immediate problem of acquainting *all* the farmers with the extent of erosion, the effects of it, and the methods for controlling it. With this in mind, we selected nine farms scattered throughout the district, which were representative of average conditions in the area. Each of these nine farmers immediately cooperated in planning a soil and moisture conservation program which he put into effect on his farm.

Each of the nine farms became a "textbook" for the use of the surrounding farmers in learning methods and the value of soil conservation. The "textbook" was easily accessible to the farmers and it was authoritative because it was "written" by a neighbor known as a good farmer and thereby recognized as a good "author."

The district immediately obtained the help of the Soil Conservation Service, which assigned three technicians and two assistants to help farmers within the district to plan soil and moisture conservation programs for their farms.

James W. Dunn was one of the nine farmers first selected by the district to develop soil conservation plans. In 1936 Jim Dunn had moved to a 90-acre farm that had seen a succession of all types of farming. A hundred years ago the farm was helping support the "wheat kings" of the community. In the early part of the 20th century, when crop yields declined, the pioneer family left the farm to a succession of short-term tenants whose parade across these acres left enlarging subsoil areas and lateral ditches gnawing away from a creek that bisects the farm.

The farm changed owners just before Jim moved to the land. The new landlord, who had pioneered in the use of limestone and phosphate on another farm, started liming the soil. By 1938 corn yields were boosted from 10 bushels per acre to about 30 bushels; wheat yields showed no change.

He was interested in improving his farm and had investigated the work of the University Extension Service and the Soil Conservation Service. He was anxious to take advantage of the technical advice

extended to him by the Soil Conservation Service technicians to set up one of the first soil conservation demonstrations in the district. So he spent a good deal of time with the agronomist and engineer.

The soil conservation survey showing slopes, soil types, and amount of erosion was the basis of their discussions. The technicians—locally known as "the district men"—explained the unfamiliar symbols on the map; they taught Jim to "know" his farm. He learned the areas that are least susceptible to erosion, the areas where erosion has done the most damage, and where it hits the hardest. He learned the crops that can be grown with least danger of erosion and those that "aid" erosion and should be confined to certain areas.

The "district men" got Jim's ideas on how he would like to operate his farm. Then, carefully, thoroughly, he and the district men worked out a complete plan of conservation operation for his farm. "This course of development fooled nobody," says Jim, "but it did give me some pride in planning my work, and it developed a vast respect on my part for the thoroughness of the research and experience on which such planning is based."

The farm plan that was formulated furnishes a balanced livestock production sufficient to provide a modest income. The plan calls for 4-year rotation of corn, wheat, sweetclover pasture, and wheat with sweetclover catch crop in four 13-acre fields. The fields are laid out on the contour for 1940 operation, and 3,800 feet of terraces are to be made in one field where the terrace outlet, constructed in 1939, is sufficiently seeded to grass. One of these terraces serves as a guideline for contouring the fields. Two alfalfa fields of 5 acres each provide hay. Permanent pasture has been increased from 6 to 17 acres.

Four acres of unpastured timber will remain, with wildlife food provisions nearby. The number of quail has been increased under the game control plan of the district. The cooperation of the State Department of Conservation has been very helpful in this connection. The lateral gullies from the creek are to be planted with black locust and wildlife shrubs.

All these details of Jim's proposed plan of operations are incorporated in tabular and written form easily understood and serving as the basis for an agreement which he signed with the district.

He attended a meeting of the University Extension Service where soils and crops were discussed and learned how to work out the plant-food balance for the new rotation. He found that, with the addition of limestone and phosphate, the plant-food content of the soil should increase.

"One year's operation under the district agreement has shown an increase in corn production of about 15 bushels per acre, and wheat production is doubled," Jim now declares. "No troublesome gullies appeared in the last wheat harvest as they had in previous years."

The farm plan is not perfect and probably is not completed. The rotation requires that some corn be cut to make way for wheat. A solution to this problem would be a spring green grain comparable to wheat in value and as a clover nurse crop. Spring barley adapted to southern Illinois would be useful. This problem is not confined to this farm, however, but is general in the area, and has been intensified by the coming of the combine which does not work well in oats. The farm plan develops more roughage than present livestock consumes, and there is some waste. A logical solution here may be to increase livestock numbers carefully and to harvest a sweetclover seed crop.

Nine "textbooks" on soil conservation planning similar to that for the James W. Dunn farm were developed over the county. After the final plan was made and agreed upon by the respective farm owners and operators and the district, small groups of farmers were invited to visit the farms where the planned programs were discussed. During these small tours, farmers in the district began to get a "working" picture of the objectives of the district.

In assisting farmers in the formulation of farm conservation plans, various methods of procedure were tried out in the early stages of district undertaking. At first, each of the three Soil Conservation Service men assigned to the district visited all the farms to offer advice in his special field of knowledge. This was excellent in the interest of thoroughness and was warranted in the early work, but soon it became apparent that such an arrangement was too slow to permit rapid advancement of the district plans. Furthermore, each technician soon became a conservationist so that it was not difficult for him to represent the others' specialties along with his own.

Under present arrangements, all applications for assistance received are held until the next directors' meeting. Then at the meeting we, the directors, approve the applications in the order of the date they were received, and assign each one to a conservationist. A personal letter, explaining in general the soil conservation program and the facilities available, is sent by one of us to each of the applicants. Usually the applicant has had the opportunity at some small meeting to go over a land-capability map of his farm and he has

already a general idea of the proper land use for his land.

When the conservationist makes his first call on the farmer, together they go over this map and attempt to apply their combined knowledge to the operation of the farm. At this time the conservationist obtains all possible information relative to the farmer's business and his general economic condition. The farmer, in turn, learns in more detail the operation of the district. On this first visit the conservationist points out where possible practices might be applicable and practical, and, if the farmer is receptive to these suggestions, plans are made for the necessary surveys.

In the process of formulating the land-use plan, the work phases become apparent to the farmer. He is asked to assist in the surveys for terraces, strip cropping, structures, etc. The farmer's participation in surveys, etc., not only gives him a better idea of his plan, but also reduces the amount of time that must be spent by the district men on the farm.

Finally the plan reaches the stage where the land use for the farm is decided upon. Future field arrangements and crop rotations are outlined, cost of installation of various practices are determined, livestock and market facilities have been discussed, and the time for execution of various parts of the program is agreed upon. The cooperative agreement is then drawn up and signed by the owner, operator, and by one of the directors. The completed plans are turned over to the two assistants. These men are responsible for giving the farmers enough assistance for putting the plans into effect. As more agreements have been signed, this matter of assistance has become a real problem. With little more than a year of work behind us, it is difficult to venture a solution to the problem, but several things are apparent. First, we must hold more group training meetings where several farmers may be shown how to do a certain thing. Too, the conservationists will no doubt find it necessary to drop their planning work during the rush seasons and assist in the execution. We believe our most important task is putting the plans into operation, for plans on paper will not control erosion in the fields.

The problem of a general lack of knowledge of what soil conservation means was not solved by the nine "textbook" farms. Some farmers have only the plugging of gullies in mind, others are interested only in a pond, and still others are concerned about the establishment of woodland and wildlife areas. After the district had been in operation for only a short time this problem became very noticeable. We

(Continued on p. 128)

THIRTY YEARS OF VERTICAL FARMING

(Continued from p. 115)

snow of 1940, indeed, even those caused by the rains that had fallen since the last cultivation of potatoes in July 1940.

Some fields that had a soil depth of more than 3 feet to bedrock in 1908 had less than 6 inches over about a fourth of their area in 1940. On one farm that was terraced this year, the soil had been washed so shallow that the terrace channel had to be blasted through 1 to 2 feet of limestone rock in order to get the proper depth and gradient. In an adjacent sloping field on a farm lying above this terraced field, where the potato rows all ran straight downhill, it was found by measuring the size of the washes in the furrows since the rain of July 25 when 1.13 inches fell, that 35 tons of soil per acre had washed down into the strip of vegetation along the farm boundary or on across the lower farm. The total erosion from this upper field had averaged one-fourth of an inch of soil per acre for the rains that fell between the last cultivation on July 21, 1940, to September 1, 1940, and approximately an inch for all the rains and melting snow of 1940 up to the same date.

In another adjacent field, where potatoes have been grown almost continuously for several decades, I walked a distance of 550 feet along a shallow gully that had cut down to bedrock. Adjacent to this gully, the soil, or rather the subsoil that was left after years of erosion, ranged from about 2 to 4 inches to bedrock along most of the distance.

Here was a field where the combined soil and subsoil depth was at least 2 feet 32 years ago, in which the average depth of subsoil—the original topsoil is all gone—is less than 12 inches deep today. Some of it is too shallow to plow now; most of it is too shallow to terrace; all of it will be too shallow to cultivate with a few more years of use without protection. In other words, more than a foot of soil and subsoil, amounting to some 16,000 tons (32,000,000 pounds) per acre, has been unnecessarily wasted in this field over a period of about 25 years of cultivation.

I said “unnecessarily” wasted. It would not be quite precise to leave it that way, because people were not thinking about erosion in this section, as in most other parts of the United States, and so until recently they were doing little to stop it. On 123 farms, comprising 18,000 acres, in the Aroos-

took soil conservation demonstration area, erosion has been so controlled or reduced with the aids of terracing, contour cultivating, strip cropping, crop rotations on the contour, retirement of excessively steep slopes and slopes with soil worn too shallow to the permanent protection of trees or grass, that people are beginning to realize that such controls must be recognized and made a part of good farm practice.

I am convinced that they will become a part of good farm practice. Interest is spreading, State and Federal agencies are working together to help farmers with the soil conservation problem. I even ran into potato machines that were being worked on with the view of effecting adjustments that would make them work better on terraced land.

For a time there was fear that potatoes would rot because of the water conserved in contoured rows, but that fear appears to be fading in the light of experience. In 1938, a rather wet year, contoured potatoes on 19 of 32 farms in the Aroostook project produced an average of 117.6 bushels of good-quality potatoes per acre, as against 107.2 bushels for up-and-down the slope potatoes on the other farms. Of the contour-cultivated potatoes, 66 percent of the samples showed rotten tubers; of the non-contour-grown potatoes 72 percent showed rotten tubers.

Accordingly, the objections are being met, the fears are fading out, and conservation is spreading. It must spread; it must go fast; it must quickly get away from vertical agriculture—up-and-down the slope farming—if the rolling lands of Aroostook County are to continue in use for clean-tillage agriculture. More organic matter must be worked into the soil, and the best way to meet this acute need is to work more legumes and grass into the rotations, and, undoubtedly, the best way for this to be done is for the farmers to raise more livestock.

All this is intended to show what can happen to land if those natural laws that man cannot repeal or amend are overlooked too long; and how man can advantageously adjust his ways of using the land to the ways of nature—adjusting land use to the ways of flowing, biting water that bites harder and deeper into the living flesh of productive fields when man fails to cooperate and get along with nature.

Also, a lot can happen to land within a generation.

ECOLOGY AND LAND USE

BY EDWARD H. GRAHAM ¹

Ecology is not so much a special branch of biology—in the sense that genetics or the physiology of nutrition are special branches—as a way of regarding animal and plant life.—A. G. Tansley.

AULUS, the Roman, spoke proudly when he announced that at last they knew malaria was caused by the night air. Then, like other intelligent Romans of his day, he ordered all the doors and windows of his home tightly closed from sundown to sunrise to exclude the “pestilence that walketh by night.” Little did the Romans realize that 1,500 years would pass before the truth would be known about malaria—that the disease is carried by the *Anopheles* mosquito. Yet of all the plagues of human history malaria probably has taken the heaviest toll of human lives. For twenty-five hundred years it has persisted throughout many parts of the world. Before the rise of Rome it was recognized as the most deadly enemy of the Athenian Empire, and if she had conquered malaria, Athens would have ruled the world. Ancient Rome lost more soldiers to malaria than to her enemies.

The Roman authorities tried diligently to discover the cause of this plague, and came near the solution, for they found a relationship between the disease and the night air, and closing their homes at night was correct procedure. But the next step in man's knowledge of this malady was delayed 15 centuries until someone began to look for further relationships. Even then, long, patient experiment was necessary to learn the baffling fact that infective transmission requires a certain interval of time, that only a few of more than 100 species of mosquitoes can transmit malaria from one person to another, and that of these it is the female alone which carries the disease.

What we know now about malaria we have learned by attempting to deal with all factors affecting the situation, instead of considering a single factor to the exclusion of others that might have an equally important influence. This is an example of ecological thinking.

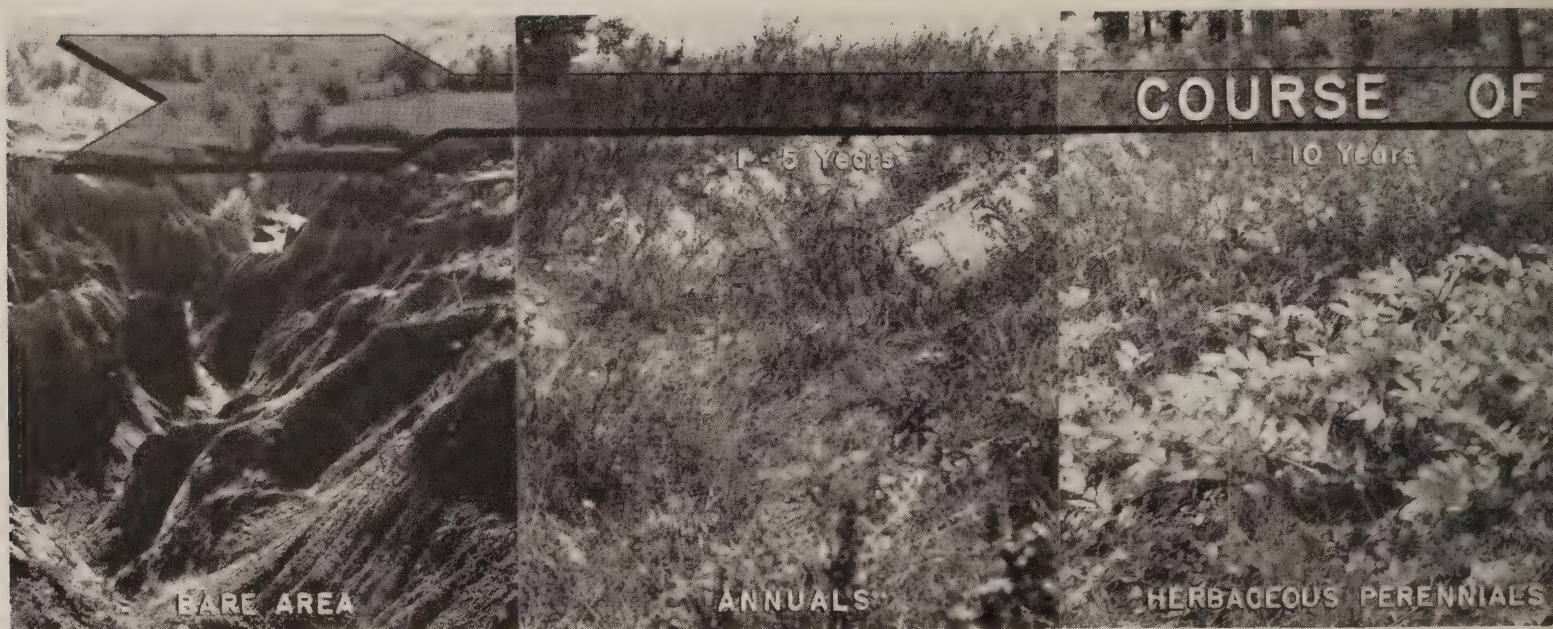
Some day we shall look back tolerantly upon the time when bounties were paid for hawks and owls, while men lamented the presence of mice and snakes, upon which such predatory birds, if unmolested, effect some measure of control. Shall we not knowingly shake our heads when we recall the widespread efforts of those who so enthusiastically stocked with game habitats unfit to support it, and planted fish in streams and ponds where there was no likelihood of their survival? Game laws not ecologically sound will seem absurd, for the relationship between animals and their environment will be better understood. Even now we know that high populations of deer in the Northeastern States have been possible because food was supplied by second growth browse that sprang up where virgin forests were cut away, and that as this browse matures into forest trees it

will no longer be good deer food, and the deer will starve. When that happens the most stringent protective laws will be unable to preserve the animals unless management methods based upon a knowledge of existing relationships are first applied to the land.

In the program of the Soil Conservation Service a fundamental concept is that of a coordinated approach on the part of several technical fields toward the solution of a common problem—soil erosion. This concept is based on the relationship of the land owner to his environment—the farm which he operates and the market which absorbs his production. A sound agricultural program will result in a balanced condition where crops and soil, rainfall and run-off, birds and insects, yield and market, and all other components of the farm as a habitat, are in adjustment. In this light, prevention of soil erosion on agricultural land, like every conservation endeavor, is fundamentally an ecological problem.

That farming involves many ecological patterns is illustrated in the following example: For a long time agriculturists advised against the use of a permanent ground cover of herbaceous vegetation in southern California pear, avocado, and citrus orchards. It was

¹ Biologist, biology division, Soil Conservation Service, Washington, D. C.



believed that a ground cover of vegetation sheltered field mice and other rodents which ate the bark and roots of trees, provided protection to injurious scale insects, increased irrigation costs by absorbing water, and, through competition for nutrients, reduced fruit yields. However, orchards maintained for a great many years in permanent cover of herbaceous perennial legumes and grasses have demonstrated that yields are not reduced under this practice. On the contrary, packing house records show yields from these orchards to be much higher than the average; they also bring better than average prices. Furthermore, operation and irrigation costs are low. Irrigation is accomplished by flooding from furrows constructed across the slope, the water being spread by the dense plant cover which, by providing infiltration into the soil in place of rapid run-off, actually conserves water.

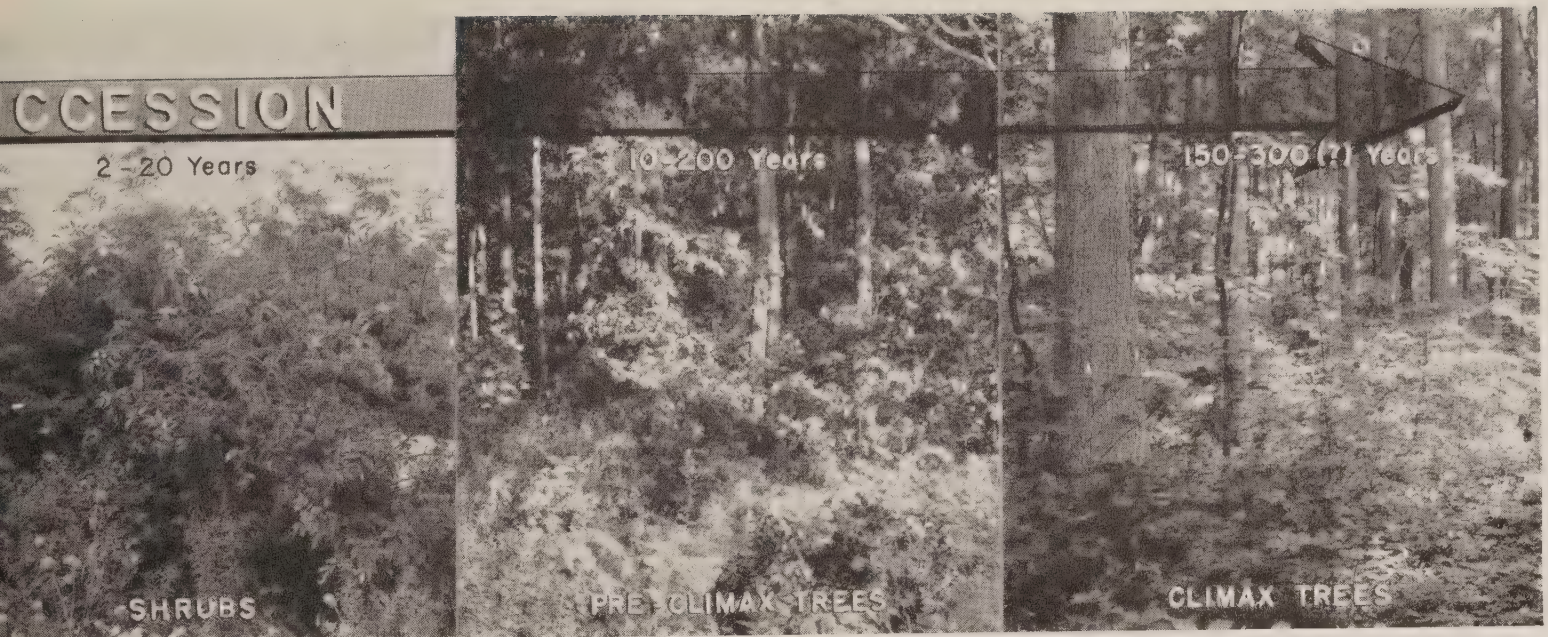
Flood irrigation in itself is an effective aid in controlling gophers and other small rodents, and the cover of herbaceous vegetation supplies food for mice that no longer are forced to feed on the trees. The ground cover harbors predaceous insects and ground nesting birds that help naturally to combat insect pests. Permanent cover likewise obviates annual seeding, practically eliminates cultivation costs, prevents interference with feeder roots of the trees located near the surface of the ground, and prevents soil erosion. Thus the invaluable soil resource is permanently protected, and harmonious relationships are established among the biological components of the orchard community which it is to man's advantage to understand and maintain.

In farm woodlands man profits by knowing something of ecology. The snowshoe hare of our Lake

States forests is often blindly charged with intolerable injury to young trees. This is especially true on clean-cut or burned-over areas where natural reproduction results in very thick stands. Now the hare is a highly cyclic species, with "highs" of large populations occurring at 10-year intervals. When the hare population is at its peak the animals eat, girdle, or prune the young trees until the stand is so open that they may be easily seen by predatory mammals, owls, and hawks. The hares must then retreat to thicker stands for protection. They may return at intervals of a few years whenever the trees have again thickened enough to form protective cover, and may thin out the stand recurrently until the bark becomes too thick to be palatable. Instead of being an unmitigated evil, however, the opening of the stand in each case permits the remaining trees to recover from their stunted condition, helps to reduce the fire hazard, and minimizes insect damage.

In northern Minnesota the value of the thinning operations of the snowshoe hare is set at a high figure. Furthermore, foresters have learned that in this region plantations of trees show a much higher percentage of survival if the plantings are thin, in which case they do not provide escape cover under which the snowshoe hares can work, and that there is minimum damage if plantings are correlated with "lows", in the population cycle of the hare.

Small forest animals, such as shrews, moles, mice, and chipmunks, have long been listed on the debit side of the forester's ledger, because they eat seeds and damage tree seedlings. Yet, recent studies show that small animals inhabiting the forest floor eat an astonishing number of insects, many of them larval forms of species highly destructive to mature trees.



The insect-destroying values of these mammals may be even higher than the values of insectivorous birds, for the number of such animals per acre is greater than the number of birds, and, unlike most birds, the mammals are resident and usually active throughout the year. It is conceivable that, without forest animals, we might have no forest at all.

The older forest plantations of continental Europe, planted to pure stands of spruce or pine, once were lauded for the neat appearance of row after row of similar trees. Today we know that soils are depleted under a uniform type of forest cover, and that disease is prevalent because it can spread more easily than in mixed stands. In such European forests insect damage is so widespread that bird boxes are being installed in an attempt to restore artificially some semblance of the biological balance which was lost by man's failure to think ecologically.

To the ecologist there is real significance in the adage that man must learn to work with nature, not against her. But the ways of nature are not easy to learn. The following example illustrates this: If a coyote is observed to kill a lamb a fact is established, namely, that coyotes kill lambs. Since lambs are desirable, the obvious conclusion seems to be that coyotes must be destroyed if lambs are to survive. This is the simplest deduction—but it does not represent ecological thinking. The ecologist wants to know how the destruction of coyotes affects other things. Unfortunately, much more money and effort have been spent in destroying coyotes than in attempting to learn the place they occupy in the biological complex of which they are a part. Nevertheless, we have learned enough about their food habits to know that they live on rabbits and various small rodents to a substantially greater extent than on lambs.

Of rabbits and rodents that live throughout the range of the coyote another isolated fact is apparent—rabbits and rodents eat grass. This simple relationship seems also to interfere with an activity of man, for cattle and sheep likewise eat grass. The obvious conclusion is that rabbits and rodents should be destroyed to preserve food for livestock.

But it is apparent that the destruction of coyotes and the simultaneous destruction of rodents, on which coyotes naturally prey, is illogical. For if man did not reduce the number of rodents by poisoning, the coyotes, finding their natural food more abundant, might feed more upon rodents, and less upon lambs. There would then be less need to kill coyotes. Also the rodents thus naturally reduced in numbers, would compete less with livestock for food, and man could put to better profit much money he now spends in rodent and predator control.

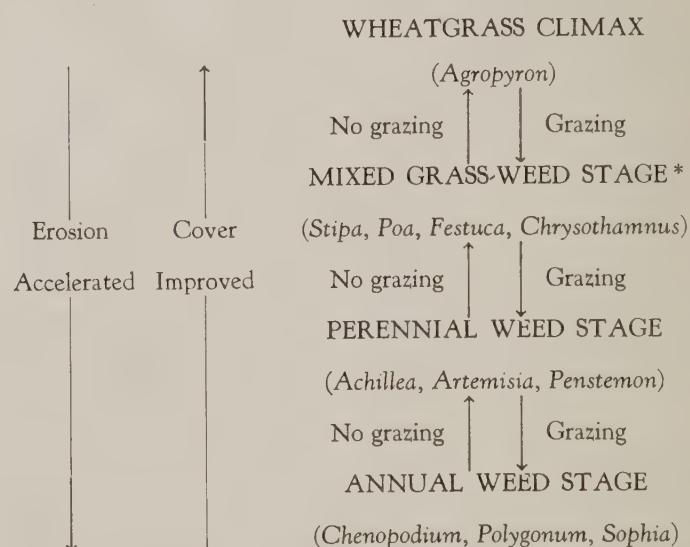
Of course, practical management of wild animals in relation to range land is not as simple as the writing of the preceding paragraph, but a consideration of the interrelationships stated is a simple example of ecological thinking. From this knowledge the ecologist wants to go forward—to learn more about other relationships between coyotes, rodents, man's domesticated animals, and the vegetation of the range, until he discovers what factors, if any, must be modified to attain the biological balance that will provide the maximum return from the land consistent with its best use and long-time productivity. It may well be that regulation of livestock grazing to the carrying capacity of the range may prove to be the management measure that will keep both rodents and their predators under control. Proper grazing is a way of working with nature and may upset the desired balance less

than any other kind of disturbance man might introduce. Ecologists might profitably be employed to learn more about these relationships.

Today we hear more and more about ecology. We hear that conservation of resources is attainable only if founded upon ecological principles; that many subjects, such as geography, are properly taught only when treated as human ecology; and that the tumultuous unrest of the world today exists because man has held more to political than ecological tenets. Such ideas are based on the conventional definition of ecology—the science of the relation of living things to their environment. The concept of ecology as a science, however, connotes a language of unfamiliar technical terms and a knowledge available only to the specialist. But in a broad sense, ecology is much more a process of thought than a science, and as such is useful to a great many persons. To think ecologically requires only a knowledge of facts and an ability to relate them correctly. Anyone can utilize this type of reasoning, although to arrive at a solution in specialized fields a trained ecologist may be required to interpret accurately the facts and place them in their proper relation to each other.

The ecologist finds practical as well as theoretical usefulness in the concept called succession. This concept contends that primeval vegetation undisturbed by man, whether it be forest, grassland, or desert, is in essential equilibrium with the climate. Such vegetation is considered climax for the region and will perpetuate itself. If the climax vegetation is removed from an area, it is not reestablished until several different plant communities have successively occupied the area, each more like the climax type than the preceding. For instance, if a virgin hemlock-hardwood forest is destroyed by lumbering, it is not a stand of young hemlock and hardwoods that immediately begins to replace the cut-off trees. Instead there first springs up a growth of annuals, usually widespread weeds. A few years later this is succeeded by a cover of herbaceous perennials. Still later shrubs invade the area and finally, after many years, trees such as cherry, aspen, and birch appear. In the course of a long time, these trees are gradually replaced by climax species of hemlock and hardwood, to produce eventually the type of forest originally on the land. Of course, many kinds of disturbance, as fire, cultivation, and erosion, may modify this succession, and man's activity ever tends to prevent its progress; but it is an ecological law that the vegetation of a disturbed area attempts incessantly to return to its original climax composition that is in equilibrium with the climate of the area.

Anyone familiar with the stages through which a given succession must progress in reproducing the climax type, can tell from the plant cover of a disturbed area how far it has developed toward duplication of the original vegetation. Likewise, if he watches an area over a period of years, he can determine whether it is progressing toward the climax or retrogressing toward a lower stage in succession, as it does under misuse and erosion. Man is only beginning to learn how to apply this principle to his daily activities, although a generation ago ecologists learned that in the wheatgrass grazing land of central Utah the species of plants increasing on the range tell one of two stories. If plants appearing on the range belong to a stage lower in succession than the predominant vegetation, the range is deteriorating, a condition brought about by misuse, as overgrazing; if invading plants belong to a higher successional stage, then the range is improving. The situation may be diagrammed:



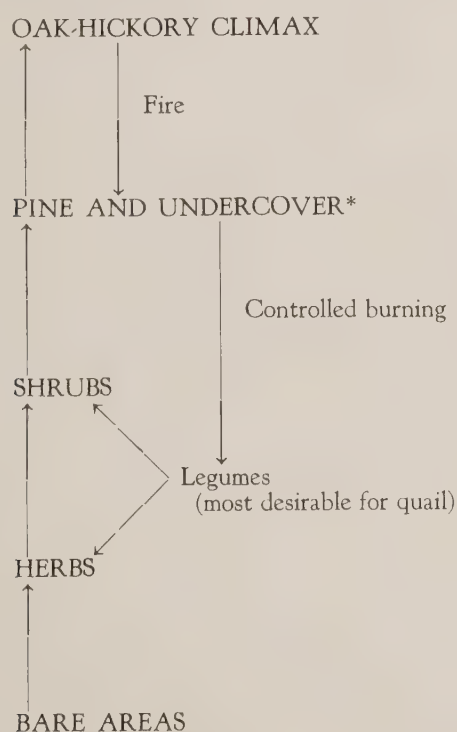
* Because the variety of palatable plants makes this stage the most desirable for grazing all classes of stock, the range manager will attempt, by proper stocking, to maintain the range in this condition.

No amount of money spent on weed control when the range is in the annual weed stage, or even in the perennial weed stage, can successfully eliminate weeds. The only economic way to control weeds is to remove the cause of their appearance, in this case overgrazing. When grazing pressure is relieved, the natural process of plant succession will inevitably replace the weeds with more desirable plant species—and at no cost to man.

More recent studies of the vegetation of abandoned fields in western Nebraska indicate that it is possible to determine, from the plants growing there, exactly how many years ago a particular field was last cultivated. Consequently, an ecological knowledge of plant communities and succession makes it possible

not only to understand something of the past history of a parcel of land, but to predict its future as well, which, in the last analysis, is one of the greatest tests of the usefulness of any human discipline.

That man, by proper management, can maintain native vegetation in a condition suitable to his needs, that he can "arrest" succession, is a comparatively new thought. It would seem to be valuable in range and pasture management, forestry, and nearly every agricultural practice dealing with plants except the cultivation of annual crops. The biologist has been quick to utilize this principle. For example, game managers in the Southeast have learned how to maintain beneath open stands of longleaf pine a heavy undergrowth of native leguminous plants invaluable as food for the bobwhite quail. This is done by carefully controlled, light, periodic burning of the forest floor. Such a practice also aids in maintaining the forest of longleaf pine, for burning encourages reproduction of this species, and the resulting heavy herbaceous vegetation may well provide better grazing, although little attention has yet been given by ecologists to these further relationships. The result of burning as a quail-management practice may be diagrammed as follows:



*The stage commonly dominant for the "Southern Pine" region, due to recurrent, uncontrolled, heavy burning, even prior to the advent of white men.

In any program aimed at the proper use of land, ecological thinking is a prerequisite. Interrelationships of plants, animals, and man with the physical environment, the trend of plant succession and how to make use of it, and attention to many minor axioms

of ecology must be considered, else man pushes a wagon with the brakes on. The attempt of the Soil Conservation Service to apply use-capabilities to types of land is of interest in this regard. This scheme recognizes a relationship between several factors such as soil type, degree of slope, vegetative cover, erosion, and the best adapted land use. To maintain some semblance of balance between use and conservation of land, it is generally true that disturbance of the soil must decrease as the slope of the land increases. Therefore, on the steepest and most erodible slopes a protected permanent cover of vegetation, as forest or prairie sod, must be preserved. On slopes less easily disturbed, carefully managed pasture may prove a wise land use. Still gentler slopes may be cultivated with careful application of soil-conserving practices, including, perhaps, long periods in grass rotation, while constant disturbance may be safe on the most level and least erodible areas. The designation of specific land-use capabilities for various types of land according to a consideration of all their physical properties represents a concrete application of ecological thinking.

Another matter in which the ecologist is interested is what happens when non-native plants or animals are introduced into a region. In older countries, such as England, some sort of biological balance has been attained, but in newer countries the consequences of introductions are not easily predicted and may present extremely complicated biological interactions. For example, some zealous gardener, who wanted to make Hawaii even more beautiful than it was, introduced there an ornamental tropical American shrub, *Lantana camara*. In its home this plant "knows its place" but, as we shall see, in Hawaii it took full advantage of its new association.

Some time before the introduction of this shrub, turtle doves from China had been brought to Hawaii, and Indian mynah birds also were introduced. Unlike natives, these two birds fed heavily upon *Lantana* fruits. The aggressiveness the plant displayed in its new habitat plus the capacity of the exotic birds to distribute the seeds combined to make the plant a serious pest in parts of the islands devoted to grazing. But there is even more to the story. Before the mynahs were introduced, the Hawaiian grasslands and young sugarcane plantations had been severely damaged by armyworm caterpillars. When the mynahs came, however, they helped to keep the armyworms under control. Meanwhile someone got the idea that certain foreign insects would check the spread of *Lantana* by eating the seeds. Consequently, insects were introduced. As predicted, they destroyed so much seed that the

Lantana began to decrease. Then the mynahs, deprived of Lantana seeds for food, likewise began to decrease. This resulted in a recurrence of armyworm outbreaks. Furthermore, many of the places now vacated by the Lantana shrub became occupied by other introduced shrubs, even more difficult to eradicate than Lantana. Here is a lesson about the reckless introduction of exotics, for the result in this instance was an ecologically unbalanced situation becoming for man a long difficult task in bringing about some sort of desirable stabilization.

In the United States much damage has been caused by exotics, such as the chestnut blight, Hessian fly, cotton boll weevil, and weeds, most of which are Eurasian plants. Of course, native species may also cause trouble, as do the grasshoppers of the Great Plains. In defense of introductions, one might argue that many of the cultivated crops of the United States and nearly all of our domesticated animals are non-native species. For the most part they survive, however, only when tended carefully by man. This discussion is not intended as a statement to the effect that introductions are necessarily harmful, but rather to emphasize the fact that great care must be exercised in tampering with the ecology of an area, and that it is imperative for his well-being that man think

ecologically as well as in terms of simple cause and effect relationships.

We live in an environment of many facets related not as single pieces, but as a mosaic, the pattern of which is not appreciated at first glance but must be seen in different lights to disclose its true design and its real worth. Thus it is easy for man to look to immediate gain, forgetful of the long-time advantage. But to achieve a lasting economy he must consider all the implications of his operations on the land. Might it not have been possible to prevent the passage of homestead laws that once encouraged families to live on land incapable of supporting them? Might the Great Plains have been spared the devastation that resulted from wholesale plowing of the sod with no regard for consequences? Could drainage that exposed land worth less than the cost of drainage operations, and many other activities we now regret, have been avoided? Is what we plan today equally unwise, or are we prepared to consider all the interrelationships our actions might involve, and act upon that knowledge? It is not an easy responsibility. Ecological thinking is one discipline to aid man in dealing with the world in which he lives, and one to which, in the future, he must be forced more and more to give attention.

TO PROMOTE THE GENERAL WELFARE

(Continued from p. 121)

discussed it with the county farm adviser and the Soil Conservation Service personnel. We decided that a strong educational program was urgently needed.

Exhibits and pictures were shown wherever possible. A news article on the activities of the district has appeared in the local papers every week since the district office was established. The Extension Service, organized farmer groups and committees, the State Soil Conservation Board, the Illinois Department of Conservation, the Farm Security Administration, and the Agricultural Adjustment Administration have all cooperated with the district in this effort to acquaint people with the district program. The result of this cooperation is a better understanding on the part of personnel directly assisting the district of all programs in the county that are sponsored by various agencies. It has also encouraged farmers to utilize the opportunities afforded by these agencies, and thus the agriculture is improved.

There is one thing that the 1½ years' work has made us sure of—that the district program is *sound*. Farmers participating in the district program learn soil conservation by their own efforts. They take

pride in displaying their work, and are developing a real sense of appreciation of the results of that work.

A trip over the district and talks to other cooperators bring forth the same expression of belief in soil conservation, admiration for the district's work, and the vision of fuller, more enjoyable farm living. Unheard, unseen, but instinctively felt, is the deep satisfaction of pioneering on something that is vital and far-reaching for the welfare of the people and the land.

The importance of crop rotations in saving soil is set forth by the Arkansas Experiment Station in its Fifty-First Annual Report. Under continuous production of corn on Clarksville silt loam with a 6-percent slope, soil was lost at the rate of nearly 5 tons per acre annually. With a 3-year rotation of corn, winter oats, and red clover, the ground was well covered about 85 percent of the time and the loss of soil averaged about one-third of a ton per acre annually. What is more, the rate of loss has been increasing with continuous corn and decreasing with the rotation of crops.—A. T. Semple.

SOIL EROSION IN GREECE

BY CONSTANTINE I. NEVROS¹

AN INTERESTING article entitled "Poor Man's Cow" on the position of goat breeding in Greece appeared in *SOIL CONSERVATION* for October, 1938. The goat has many virtues, but it should not be forgotten that the goat is the animal responsible for the extensive destruction of Greek forestry, the consequent erosion of the soil of Greece, and the barren and arid character of so much of the country.

The history of soil erosion in Greece is not without interest. In classical times large portions of Greek forests were felled to provide lumber for the construction of Athenian triremes, but even before that time, according to Plato, forests were destroyed and in mountainous regions were often razed for various reasons. Even so, the phenomenon of erosion was of a rather local character. The goat was not so important as a destroyer in those days. The nomadic stock breeders of antiquity had at their disposal, in a country more or less thinly populated, sufficient valley land to allow them to remain in the lowlands.

The serious destruction to Greek forests appears to have started during the Roman invasion in Macedonia. The Greeks lost their fields in the fertile plains, and took refuge in the mountains where they were forced to become stock breeders. The goat was to them the ideal animal because it can feed on twigs and shrubs unsuited to sheep and cattle. The descendants of these refugees appear to be the modern nomad Greek mountaineers.

The Turkish domination of Greece had a similar effect. On a larger scale than during the Roman occupation, the Greeks lost their fields and took refuge in the mountains where stock breeding was the only possible occupation. Arboriculture was out of the question because cultivation of trees requires a high agricultural standard and sufficient means of transport to markets.

The "poor man's cow," now in large domesticated herds, set about its destructive work. Every shoot and twig was nipped off as food as soon as it showed. When the large trees died they were not replaced and the hillsides gradually became bald spaces at the mercy of the winter rains. Erosion followed the dainty cloven-hoofed prints of the goats.

Owing to the country's mountainous formation, the destructive effects of erosion in Greece were unusually

rapid. Without vegetation the sloping sides of the mountains were incapable of holding together the soil, which was carried away by the torrential rains to the plains, which in turn became flooded marshes in the spring.

Few efforts were made to check the deadly work of erosion. In the Greek islands and along the coast, where climatic conditions favoured the production of valuable agricultural products such as currants, olive oil, and fruits, terraces and drains were built. The restricted areas of plains available in the islands did not permit the abandonment of the soil. It was found possible to hold it together by terraces up to the summits of the mountains.

Only within recent years, and especially under the present Government, did Greece perceive the danger and take steps to combat it. Today a systematic program for planting trees on the slopes of mountains and channelizing the torrents is being carried out.

The goat was recognized as the evil genius of erosion in Greece, but the problem was not an easy matter in view of the income derived from goat breeding. This is estimated to be about 738,000,000 drachmas [100 drachmas equals about \$0.70] annually, while the aggregate value of goats in Greece is estimated in the neighborhood of 1,600,000,000 drachmas. Some other means of livelihood must be found to replace the goat. Their mountaineer owners could not readily be absorbed on the plains.

The present National Government, after careful investigation of the question, seized the problem by its curving horns and passed the Compulsory Law No. 875 of September 28, 1937, by which it is provided that the goat will disappear gradually within a period of 10 years from those regions where it is injurious.

To help in this great work, the Institute of Chemistry and Agriculture, "Nicolaos Canellopoulos," organized a special research department to deal with soil conservation. The department, besides its purely scientific work, has issued a soil map of Greece,² and special educational pamphlets on the systematic use of the soil.

The Greek soil, if cultivated systematically, can feed double the number of the present population (about 7,200,000). To do this, however, every square inch of soil must be preserved.

¹ General technical director of a chemical products and fertilizer company, Pitaens, Greece.

² The plates for Crete, Euboea, Zante, have already been issued; the plate for Attica is being printed.

ACOMA AND LAGUNA INDIANS ADJUST THEIR LIVESTOCK TO THEIR RANGE

By DEWEY DISMUKE ¹

ACOMA and Laguna Indian pueblos in west-central New Mexico recently made the last in a series of livestock reductions totaling 63,000 sheep units needed to bring their 388,000 acres of overgrazed and eroded reservation ranges to grazing capacity. As a part of their 8-year cooperative agreements with the Soil Conservation Service, the two pueblos reduced stock on their reservations from a total of 86,000 sheep units in 1935 to 23,000 units early in 1940. Reduction to carrying capacity within 5 years was stipulated. But undue hardship to stockmen was avoided by making the change gradually, through several years.

Acoma and Laguna Indians have grazed sheep and goats since the early Spanish conquistadors introduced the animals shortly after 1540. Cattle raising is of more recent advent. Few animals were grazed at first. But livestock improvement, the World War stimulation of wool and lamb prices followed by the post-war slump, the lack of a sound pueblo grazing policy, and an increase in the Indian population, gradually increased the size of herds until reservation ranges became overstocked.

Conducive to overstocking was the Indian conception of wealth, a conception similar to that prevalent until recently among all western stockmen. Numbers were valued above quality. Many useless animals contributed to a gradual destruction of the pueblos' chief resource, the land. In addition, range practices remained unchanged, culling was neglected, and distinctions between livestock grades went unrecognized.

The Soil Conservation Service estimates that pueblo reservations have been overgrazed at least 25 or 30 years. Before overgrazing began, 8 or 10 acres were enough to support a ewe, but today as a result of range depletion and erosion 16 to 25 acres are needed.

As herds and flocks expanded, the valleys lost their thick, stabilizing cover of sacaton grass. From valley to mesa top, browse thinned out. Without the protective covering of grass, soil was washed by unhampered run-off. Gullies cut back up the valleys and lowered the water table. Nowhere else in the Southwest was there a more soil-impooverished area. Before the Indians realized the condition of their

ranges they were faced with a serious shortage of forage. The future of their basic livestock industry, and perhaps of their centuries-old villages, depended upon renewing the productivity of the land.

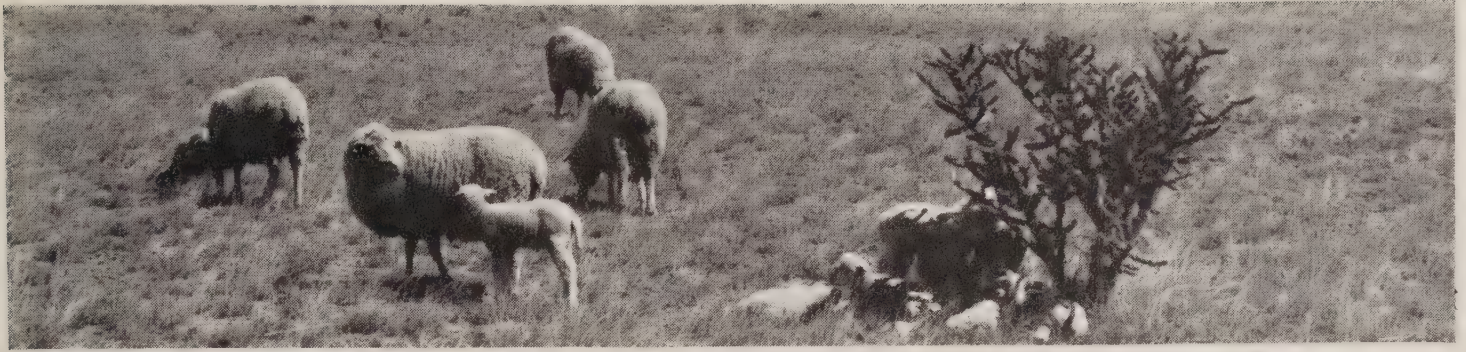
Midway in 1935, the Soil Conservation Service, collaborating with the Indian Service, held meetings with Acoma and Laguna tribal councils and livestock men to discuss a program to stabilize their range and livestock industry. Details were worked out and an 8-year cooperative agreement was achieved between each pueblo as a community, the Soil Conservation Service and the Indian Service. Under administration of the Indian Service, a start was made toward formulating land-use plans designed to rehabilitate the land and stabilize the livestock industry. Efforts of the two agencies were coordinated through a liaison officer appointed to carry out the joint plans.

Both pueblos, through their governors and councils, agreed to the livestock adjustment program voluntarily. A few of the larger owners were at first opposed, but finally agreed upon realization that the cooperation of all stockmen was necessary for the successful launching of the program, with its range improvement benefits and incidental wage work. The objectives of the livestock adjustment program were to save pueblo lands and livestock, and to foster in the Indians a sense of responsibility for the maintenance and betterment of their livestock industry.

Detailed range surveys of the land resources revealed that on the reservation ranges the Laguna stock would have to be reduced to 15,000 sheep units, and Acoma stock to 8,000 units. A tally of livestock on these two ranges in September of 1935 showed Acoma with 31,000 units and Laguna with 55,000 units. Although the Indians were favorably impressed with the general features of the program as presented, it was not easy to convince them that stabilization of the livestock industry depended upon drastic reduction of animal numbers to the estimated carrying capacity of the range.

The 238,000-acre Laguna and 150,000-acre Acoma reservation ranges support livestock which constitute the main livelihood of 2,300 Laguna and 1,200 Acoma Indians. Some means of supplementing the income from surplus livestock during the interim of range recovery had to be found to keep from completely upsetting the economic balance of these people. To lessen the hardship arising from a heavy reduction of

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Newborn lambs rest in the shade of cholla cactus at midday. Laguna sheep in the Antonio Sedillo Grant purchase area, where Indian stockmen are getting 100-percent lamb crops by following proper grazing practices—almost double the crops prior to 1935.

livestock units, additional range was provided. Government land-purchase range areas were made available through the efforts of the Indian Service to permit the Laguna Indians a total ownership of 21,686 sheep units, and the Acoma Indians a total ownership of 15,756 units. Of the 63,000 sheep units that were cut from the reservations, 14,452 were transferred to the purchase areas, leaving a total reduction in livestock ownership of 48,548 units.

Actually, the pueblos' livestock industry was not so seriously affected by reduction as was expected. As time came for each year's cut, the quota was largely filled by unproductive horses, burros, aged steers, and goats. The first appreciable reduction of strictly good producing classes was during the last cut in early 1940.

While stock adjustment is the leading phase of the range program, season of use, development of stock water, proper distribution, and proper class of livestock are also important. In addition to livestock reduction and improved range and livestock management practices, some badly needed reseeding, fencing, structural treatment, and other erosion control work was done. This work was carried out by the two governmental agencies and was accompanied by a supplementary program of livestock improvement.

Through Indian Service appropriations, money was made available to purchase registered bulls to serve the cattle on both pueblos. These bulls were introduced in 1935. Registered rams to serve approximately one-half the ewe bands were introduced in 1937. Prior to 1935 a few purebred rams and bulls had been imported, with limited success.

One of the most important changes in the livestock industry was the introduction of the cooperative plan of marketing. Livestock and wool are pooled, classified, advertised, and sold by auction to the highest bidders. Some \$350,000 worth of livestock and wool have been so disposed of in the 5 years, at more than a 10-percent increase in price. Better shearing methods were introduced.

The large numbers of owners involved—250 at Laguna and 175 at Acoma—makes the future of the program dependent upon full cooperation in carrying out the original plan. It is expected that consistent improvement in quality, intensive culling, and careful selection of replacement animals will help the Indians to make about as much money as they made from the tame ranges in the overstocked area prior to 1935.

As a part of the conservation program, the governmental agencies have continuously carried on an educational program with the Indians to give them an understanding of the range problems, of range management, and of supplementary practices. Basically, the aim was to show the Indians how to maintain and increase their incomes from the land. Results from proper range and livestock management on the government purchase areas have served as an effective demonstration to the livestock owners of these two pueblos. In 1935 when purchase areas were made available to the Indians, they were stocked according to their estimated grazing capacities, and good range management practices followed.

Actual use records show a 20-percent increase in weight of lambs and a 50-percent rise in number of lambs raised. Wool production jumped 20 percent. Calf crops rose 30 percent and calf weights increased 20 percent. Production has fluctuated much less from year to year on the properly stocked and managed ranges than on the overstocked ranges.

Lambs from these flocks were favored in 1937 by the Kansas Agricultural College Experiment Station at Garden City, Kans. About 500 head from the Acoma and Laguna flocks were placed in an experimental feed lot. When purchased by a packer at the end of the feeding period, 75 percent of the carcasses graded premium, as against a 40-percent premium grade on other fed Western lambs for that season. They topped the packer market for the day on which they were sold.

THE COLLECTION AND PROCESSING OF BUFFALO-GRASS SEED

BY DENNIS E. GRIFFITH ¹

THE development of easy, economical methods of collecting and processing the seed of buffalo grass, *Buchloe dactyloides*, has in recent years greatly simplified the problem of establishing this species in adapted areas of the Western Gulf Region.² Previously the grass has not been widely established on new areas because of the so-called scarcity and high cost of seed and the expense of establishing it by sodding.

In 1936 it was decided that buffalo grass could play an important part in the erosion-control program by stabilizing eroded cultivated areas converted to other uses such as pastures, terrace outlets and waterways, and in improving old pastures. With this in view the Soil Conservation Service nursery at San Antonio, Tex., undertook to collect seed to supply cooperators in project and camp demonstration areas.

Seed was first collected by C. C. C. enrollees in established buffalo-grass pastures that had been closely grazed. Ordinary house brooms, with 6 inches of the straw cut off to lessen flexibility, were first used. Later, push-type stable brooms were used, greatly increasing the amount of seed material that could be collected by each man. The material was swept into shop-made dustpans, poured into burlap bags, and hauled to the nursery to be cleaned. Under average working conditions each enrollee was able to collect about 20 pounds of material an hour. When cleaned, this 20 pounds of seed material provided about two pounds of cleaned seed with a purity of less than 50 percent.

During the spring of 1937 a total of 468 pounds of cleaned seed was collected in this manner, an estimated yield of 100 pounds per acre. Considering all expenses incident to the collecting and cleaning operations, the cost was 66 cents for each pound.

During the same year the nursery staff developed and constructed a vacuum-type harvesting machine for large-scale collection of seed material. This machine consists of a 30-inch intake fan driven by a 30-horse-power motor. Galvanized pipes lead from the intake opening to the ground, terminating in three nozzles, each of which is 22 inches long with an open-

ing approximately one inch wide. Cross bars of welding steel are spaced at intervals across each nozzle to prevent large rocks and other bulky material from entering the pipes. The seed material is blown through the fan into a box where it passes over two slanting screens, the refined material being deposited in a burlap bag. The machine is mounted on a 1½-ton truck. It operates satisfactorily on closely grazed pastures where there are not many stumps and rocks.

It has been found that the cost per pound of cleaned seed is approximately the same for hand-swept and machine-harvested material.

During the fiscal years 1938 and 1939 a total of 20,513 pounds of cleaned buffalo-grass seed was harvested. Of this amount, 14,780 pounds were collected by enrollees in C. C. C. camps in central Texas, and the remainder with the machine. More than 11,531 pounds of cleaned seed was harvested during the summer and fall of 1938, and nearly 12,000 pounds during the summer and fall of 1939.

Although the cost of collecting by hand was 66 cents per pound early in 1937 and 33 cents in the fall of the same year, by autumn of 1938 and 1939 it had dropped to 15 and 24.4 cents per pound respectively. This reduction was due to the increased efficiency of the collectors, accessibility of collecting areas, and improved cleaning methods. Nearly 2,500 pounds of cleanings were not figured in the 1939 totals, although the material was distributed as seed. If these cleanings had been figured, the cost per pound would have been reduced to 20 cents.

The following tabulation presents a summary of buffalo-grass seed collecting activities for 1938, 1939, and 1940:

Fiscal year	Amount of seed collected	Cost per pound, clean seed	Average yield per acre	Percent of purity	Percent of germination
	Pounds	Dollars	Pounds	Percent	Percent
1938.....	8,971	\$0.327	125	29.18	67.12
1939.....	11,531	.146	90	41.70	58.76
1940.....	*9,257	.244	100	41.52	65.64

*2,499 pounds of cleanings not included.

It will be noted that the purity figures for 1939 and 1940 are much higher than those for 1938. This difference is explained by the fact that better cleaning methods were used.

¹ Manager, Soil Conservation Service Nursery, San Antonio, Tex.

² See articles by Guy C. Fuller in SOIL CONSERVATION: Developing Machinery for Harvesting Buffalo-Grass Seed, Jan. 1936; Machinery That Facilitates the Harvesting of Grass Seed, Dec. 1935; A Close-Up of Buffalo Grass, Native of the Great Plains, Sept. 1936.

Several methods of cleaning not used in 1938 were tried in 1939 and 1940. In 1938 the grain thresher and fanning mill were used. In 1939 a higher purity was obtained by pouring the seed material into a vat of water and floating off the good seed and some light trash. The floated material was dried by running it through a fanning mill. This operation was successful but expensive as much time was consumed in the drying process.

In September 1939 (fiscal year 1940) the nursery purchased a 40-inch all-crop seed harvester, or combine. After adjustments were made this machine greatly reduced the cost of cleaning. The tabulation-weighted averages do not bring out the difference in costs.

Plans are now being made to use a hammer mill to grind the lumps of dirt, soft rocks, sticks, and other foreign material before it is put through a cleaning machine. By adjusting the cleaning machine, we expect to obtain seed of 75-percent purity.

In most cleaning operations a large number of seed "burs" were broken up and the naked caryopses deposited with the dirt and fine stones. In one in-

stance the percentage of such caryopses ran as high as 2.66. These screenings are not wasted, but instead are distributed as seed.

For the farmer or rancher the most practical and economical method of collecting buffalo-grass seed is to sweep the seed material with brooms from closely grazed pastures, sack it and spread it on new areas without cleaning. Often a plentiful supply of this material may be obtained at low cost by sweeping up the riffles of trash and seed from wherever they may be deposited after a heavy rain. Running water will lift the seeds off the ground, carry them down the slope, and either deposit them in a stream or in riffles at the base of the slope. It has been found that seed material of this kind can be planted successfully with a cotton planter after it has been screened through one-fourth-inch mesh hardware cloth.

Plans have been made in the Western Gulf Region to harvest 20,000 pounds of cleaned buffalo-grass seed during the summer and fall of 1940, and it is believed that the experience gained during the past 3 years will make it possible to obtain seed of high quality at a comparatively low cost.

EDUCATION IN DISTRICT OPERATION

By F. S. EDMISTON¹

THE adoption and execution of the soil conservation districts program and work plan in Louisiana was preceded by an educational program that greatly facilitated progress of the work. Conservation practices such as terracing and contour cultivation have been stressed for a number of years by the Agricultural Extension Service. The large-scale demonstrations in concentrated areas as carried out by the 6 Soil Conservation Service demonstration projects and by the 11 S. C. S.-C. C. C. camps further proved the value of conservation measures and of the coordinated approach through good land-use, management and soil-conservation practices. Cooperative soil conservation and land-use demonstrations also helped greatly in paving the way for the district program. This, in addition to educational activities in the proposed districts, carried on step by step as they were being created, served to crystalize the desire for organized action—as manifested by the 98.2 percent of the votes in the 12 districts cast in favor of certain of the districts.

Three factors determine to a large degree the speed with which the work plan of a district may be executed. The first is the extent of coordination of

activities by agencies assisting the district supervisors, and the second is the extent to which farmers living within the district accept their responsibilities, collectively and individually. The third factor is the amount of assistance available to supervisors. The Soil Conservation Service is now offering assistance to 12 soil conservation districts covering virtually all the land in Louisiana subject to serious erosion.

In order that all cooperating agencies may be fully acquainted with the procedure in the district programs and with the subject matter applicable to the district, training courses or schools should be conducted for the personnel of all agricultural agencies operating within the district, and for a clear understanding of the problems the different agencies should study every phase of the district organization and objectives.

The State Soil Conservation Committee worked in the beginning to inform all State and Federal agricultural agencies in Louisiana as to details of the districts program so that they could determine in what way they could assist with the work. To this end the committee invited representatives of all agencies to attend a joint meeting. At this conference the program was thoroughly explained and copies of work

¹ State extension soil conservationist, University, La.

plans and programs of representative districts were made available for study. Two weeks later, a 2-day meeting was held by district supervisors and the agency representatives who had attended the preliminary conference. At this meeting the district supervisors were informed as to the contributions available from each, and also the requirements necessary in order to obtain this assistance.

Upon the adoption and approval of the district program and work plan, the supervisors enter into a memorandum of understanding with the United States Department of Agriculture. It is then most important that farmers and landowners be informed regarding the details of their program and work plan, especially with regard to the assistance available through their local supervisor, and the extent of technical assistance, materials, equipment, and C. C. C. camp labor that can be obtained as aid in solving individual land-use and soil-conservation problems. In order to secure group action by landowners, and to make it possible for the technicians to work economically, intensive educational work should be conducted in priority work areas when such areas are set up by the supervisors. Land-use capability maps may be used to good advantage in securing group action of farmers in farm planning and execution of the farm plan.

Most soil conservation practices lend themselves to the conducting of method demonstrations whereby a group may be shown how to establish soil conservation practices most efficiently and economically.

County agents assisted by the extension specialist and soil conservation technicians may encourage, through method demonstrations, the execution of farm plans. Other agency representatives, such as vocational agricultural teachers and workers of the Farm Security Administration and State and Federal forestry services, may help in this respect. Possibly the most important tool for use in getting soil conservation practices established on the land is the soil-building practice payment under the Agricultural Adjustment Administration. The Triple-A payments make it possible for farmers and landowners to receive help in carrying out most of the soil conservation practices established according to specifications, and usually are sufficient to take care of the greater portion of the cash outlay necessary in establishing the practices. For example, the Triple-A will pay farmers at the rate of \$1.50 per 200 linear feet of terraces constructed. Terraces must meet specifications set up by the A. A. A. committee and must be provided with suitable outlets. Payments are provided for the establishment of permanent pasture,

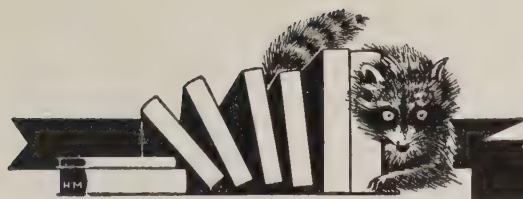
planting of forest trees, and many other soil-building practices. To stimulate further the carrying out of soil-building practices, the Triple-A will furnish as a grant-of-aid, winter-legume seed and phosphate. With such aid, and that of Soil Conservation Service technicians in the district, farmers will go forward with soil and water conservation on their land.

County agents are in a good position to advise the farmer as to ways and means of taking advantage of the opportunities offered through the districts program, and to encourage widespread application of all soil conservation practices.

Farmers living outside priority work areas should be kept informed as to the progress made, and should be encouraged to establish on their farms as many as possible of the soil-conservation practices requiring no technical assistance, such as growing summer and winter legumes and green manure crops, and protecting crop residue from fire. Cooperative soil-conservation and land-use demonstrations should be established in all communities immediately as an example to all the community of the entire program of good land-use and soil-conservation practices. These demonstrations will create interest within the community and pave the way for active cooperation and participation when assistance is available to these communities. Joint farm planning with cooperating agency representatives will result in better coordination of effort; with all agencies cooperating in the execution of the plans these demonstration farms will show early results.

It is very important to have an active organization of all agency personnel operating within a county. Usually the county agent should be chairman of the county organization. Through this organization it is possible for each agency to be familiar with the other's program, and for the entire group to coordinate all activities into the county agricultural program. With each agency making its maximum contribution, problems as they arise can be met by the group acting as a unit. Agricultural agency organizations have been functioning to good advantage in Louisiana.

It is essential that education and operations go along together; one will stimulate or facilitate the other. The personnel of all agricultural agencies operating in a county should offer their assistance to the district supervisors, in whatever capacity their agency is in a position to serve, in carrying out work plans. The problems and objectives of the districts should be kept before the farmers and the general public, through use of the press, radio, exhibits, tours, and talks before farmers' meetings, civic or other groups.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neill Faris

A VISIT TO THE UNITED STATES OF AMERICA TO STUDY SOIL CONSERVATION. By Colin Maher. Department of Agriculture, Colony and Protectorate of Kenya. Nairobi, Kenya. 1940.

Two years ago last July 24th, Colin Maher arrived in Washington from Kenya to line up an itinerary for a tour of the United States. We remember him well as the "man out of Africa" who knew what he wanted "out of America" almost before he reached our shores. Now, as he reports on his tour specifically for the benefit of Kenya, American conservationists have that rare opportunity, the chance to look at their own work from the point of view of the Chief of a "foreign" Soil Conservation Service. Mr. Maher's discernment as an observer, combined with his critical acumen, has resulted in an extraordinarily clear analysis of the works and objectives—and mistakes—of soil conservation agencies of the United States.

Mr. Maher did a thorough job of observing and studying conservation methods in this country—in 4 months he visited more than 90 projects, experimental stations, and field offices. At home, in Kenya, he had been appointed Agricultural Officer and Experimentalist in Charge of the Soil Conservation Service of the Colony and Protectorate of Kenya, East Africa, with headquarters at Nairobi. He came to America with the idea of making recommendations for a soil-conservation program for Kenya; perhaps he will return at some future time to tell us, in particular, of progress in erosion control on lands occupied by native Africans just beginning to emerge from the pastoral phase of agricultural endeavor.

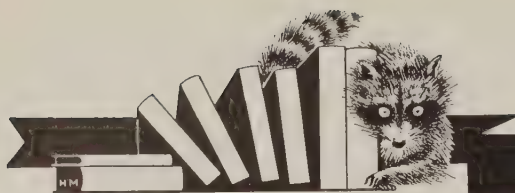
Mr. Maher's report shows two angles of thought resulting from his American observations: In the first place, he realized most keenly the importance of profiting by rule of error (in this instance, United States Department of Agriculture errors) and, second, his urgent need was for methods, plans, and practices that could be adapted to the peculiar problems of his homeland as inexpensively as possible. In pointing out the difficulties that have been and are being gradually worked out in this country for coordination of effort among many agencies and individuals pushing steadily toward efficiency in the conservation program, Mr. Maher sums up frankly what we all know, only too well, of duplication, bias of opinion, and inadequate foresight in the early days of soil conservation and land utilization programs. Nevertheless, it is apparent that he understands quite thoroughly that he is analyzing the healthy growth and development of an essential and democratic idea in a democratic Nation. Most significant is his conclusion that without doubt "the success of the Soil Conservation Service [in the United States] has been largely due to the continuous personal contact between officials and farmers" and that . . . "nevertheless, the Soil Conservation Service owes a considerable debt to the State Experiment Stations and to ecological botanists . . . and to other bureaux and agencies of the Department of Agriculture for the supply of information on agronomic matters, economics and other branches of agricultural science, which could be utilized in devising the soil conservation programmes in the various project areas." It is not difficult for those of us who became acquainted with Mr. Maher

when he was in America to imagine him, back home in Kenya, walking over Kenya's soils by day, and by lamplight pouring over voluminous notes from America in the determined effort to choose for Kenya the best out of the whole of conservation methods, practices and organization. It is to be hoped that the writing of this report of his visit to America helped him in separating detail, and in choosing and discarding means and methods for recommendation to Department of Agriculture officials at Nairobi.

Before beginning his report on what he saw two years ago in the United States, Mr. Maher states for the benefit of both this country and Kenya, that constructive criticism of soil conservation methods and policies would be welcomed, in fact was invited, by our Service. He therefore forthrightly criticizes, without mincing of words, many of the past and present (two years ago) policies and practices having to do with the use of land in the United States. His report shows that he was appalled at the results of land exploitation and farm family conditions in many of the areas through which he traveled, so that it was at times difficult for him to observe with enthusiasm the soil conservation demonstrations in scattered locations. Erosion losses of the East are emphasized, as are ecological changes of the Middle West under intensive plowing and cropping. Overgrazing of the ranges of the Southwest, difficulties in reducing livestock numbers, and costs of strip sodding, terracing and other conservation practices receive more emphasis than do the rapidly expanding areas where soil and water conservation was at that time and is today being carried out with notable success. To those of us who are in touch with the 1940 Soil Conservation Service of the United States it is consoling to know that while Mr. Maher's criticisms probably were justified two years ago, today these ills of error and over-enthusiasm are being rapidly healed by ever closer coordination of planning and work-out of plans.

In his description and appraisal of conservation achievements as he saw them throughout the various regions of this country, Mr. Maher emphasizes erosion conditions and alleviating measures by the brief outline method: Often a single sentence serves to summarize results of many months of planning and work. Such sentences are extraordinarily well chosen, however, and there is not one that does not point out an important feature, result or objective of the United States program to conserve United States soils. Projects and methods of the Southwest interested Mr. Maher in particular, judging from his report, the reason for this being, no doubt, the certain similarities as to climate, soils, topography and grazing conditions between the area and Kenya. It is obvious throughout the whole of the report that while visiting in America, Mr. Maher had foremost in his mind one picture, one thought—Kenya, and what he hoped to find in America that could be turned to good account for Kenya. For that reason his description of projects may seem somewhat sketchy from our point of view, while at the same time we have an opportunity for comparison, country-wide in scope, rarely accorded us by our own writers. Most soil conservationists will be greatly interested in Mr. Maher's impressions from this viewpoint in particular.

In his role as experimentalist, Mr. Maher visited six experiment stations in this country. He reports rather briefly on hydrologic investigations, run-off and soil losses as related to terracing, grazing



BOOK REVIEWS AND ABSTRACTS

continued

trials on range covers, control of flood flow from steep slopes, and studies of balks in row crops.

In making special studies of the Civilian Conservation Corps and some of the settlement projects of the United States, Mr. Maher apparently found many things of special interest to him. He strongly recommends a C. C. C. for Kenya, as an aid in soil conservation efforts; he is enthusiastic about settlement schemes designed toward the ideal of the self-sufficient farmer. He reviews the educational program of our Service with clarity and urges that a soil conservation education officer be appointed for his own East African country.

Exceedingly interesting is that part of his report which gives some insight into recommendations and plans for conservation of the soils of Kenya. To begin with, he expresses himself as follows: "A visit to the U. S. A. reveals * * * that parallels can be drawn, allowance being made for a difference in scale, between every agricultural or social feature leading towards soil erosion in Kenya Colony and in the United States." One is to infer, therefore, that in his opinion curative policies and procedures for Kenya's soils may be safely based on land utilization and soil conservation policies and procedures already begun in the United States at the time of his visit. Mr. Maher explains the need for surveys, of soils, water supplies, grassland resources, human and sociological conditions, for use in making regulations regarding land use in Kenya. He points out the native system of land tenure as a problem requiring much consideration and circumspect handling in order to

avoid agricultural indebtedness and "excess of the human carrying capacity of the land."

As to soil conservation methods for Kenya, provided the land-tenure and farm-size problems can be regulated, these should not be too difficult to apply since the land of the small country has not as yet been greatly exploited through over cultivation by mechanical means. Mr. Maher hopes that it will not be necessary to subsidize farmers to assist them to terrace their lands; he does recommend, however, that where terraces are necessary technical assistance be provided as under the districts organization in Southern Rhodesia and the United States. He recommends also that Kenya natives be trained as technical advisors and that simple conservation methods be introduced among native farmers as soon as possible. Contour banks, live wash-stops, regrassing and introduction of browse plants, kudzu for gully control, lespedeza for soil improvement and for hay—these are some of the soil conservation methods pointed out as important in the earlier stages of the program. Above all, as Mr. Maher wisely points out, "confidence of the natives in the soil control and land improvement work must not be forfeited through the break-down of bank or bench terraces, or of dams, which have suffered from lack of supervision in maintenance."

Finally, at the close of his report, Mr. Maher expresses his warm appreciation to "all who rendered possible my visit to the United States and to all my friends in that vast country who made my visit so liberal an education, so pleasantly acquired."

WHAT IS ECOLOGICAL THINKING?

Some years ago a farmer in New York State was complaining to a friend that there were no longer any ducks on the big marsh at the lower end of his farm.

"Herb," he said, "you're a biologist, can't you tell me why I haven't any ducks anymore? There used to be three or four broods come off that marsh every summer."

"Well, John, I don't know. It might be for any one of a dozen reasons. Let's walk down that way and take a look."

But it was not settled in one afternoon. Herb made several visits to the marsh at different seasons of the year until, bit by bit, he pieced his observations together to make a complete picture. Then the biologist met his friend again.

"The ducks are gone," he said, "because the boys are trapping all the skunks."

"Why, what in thunder have the skunks got to do with the ducks?" John retorted, "I'd think trapping the skunks was all to the good, if you ask me."

"Maybe so," continued Herb, "but the situation looks like this. Skunks dig snapping turtle eggs out of the sand where they're laid, and eat them. When

the fur prices went up and the boys started trapping skunks the turtles has a chance to multiply. But there wasn't enough food down there for them and they began to feed on the ducklings. Ducks won't nest where they are molested that way, and so they have gone somewhere else. If you want those ducks back you'll have to quit trapping the skunks. Their hides aren't worth much now anyway."

John was not convinced, but the ducks had been the pride of the whole family, so he decided to try the biologist's suggestion. Today there are as many ducks as ever. For when trapping ceased, the skunk population increased with a resultant drop in the number of snapping turtles; the turtles no longer exerted pressure on the ducks, which returned to nest at the pond; and something like the previous set of relationships was established.

The biologist had attempted in this instance to deal with all the factors affecting a given situation, instead of considering a single factor to the exclusion of others that might have an equally important influence. This is an example of ecological thinking.—Edward H. Graham.

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Compiled by **ETTA G. ROGERS**, Publications Unit



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CCC ENROLLEES TRAINED THIS YEAR IN 392 SCS CAMPS

HEAVY EQUIPMENT OPERATORS

Tractor Drivers	1,000
Grader Operators	1,000
Shovel Operators	100

EXPLOSIVES & CONSTRUCTION MEN

Blasters	400
Compressor Operators	100
Jackhammer Men	600
Concrete Construction	600
Labor Supervisors	5,100

MECHANICS

Truck Drivers	6,800
Automotive Mechanics & Helpers ...	1,500
Blacksmiths & Helpers	700

SUB-PROFESSIONAL

Engineers' Helpers	4,000
Plane Table Men	700
Draftsmen	580

CLERKS	1,400
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DECEMBER 1940

J. L. Lantow and E. L. Flory
ON
FLUCTUATING FORAGE
PRODUCTION



Melville H. Cohee
ON
SOIL CONSERVATION DISTRICTS



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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 EDITOR

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SOIL CONSERVATION



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HUGH H. BENNETT
Chief, Soil Conservation Service

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FLUCTUATING FORAGE PRODUCTION

Its Significance in Proper Range and Livestock Management on Southwestern Ranges

BY J. L. LANTOW¹ AND E. L. FLORY²

SOUTHWESTERN ranges are subject to extreme climatic fluctuations. Precipitation in particular varies widely from year to year and month to month. Annual as well as seasonal fluctuations in weather are reflected in forage production, and have their direct bearing on time of use and grazing capacity of the range. Because of this, adjustments in livestock numbers, and in the time and degree of use, often become necessary to make the range use fit the fluctuations in production. Moreover, the time and degree of forage use should not penalize plant vigor or production, but should help to conserve soil and moisture. The desired or needed changes in management or in the number of livestock should be recognized early enough to permit the making of timely changes to benefit both land and operator. Although the operator should take advantage of high production years, he should follow with timely downward adjustments in numbers of livestock if such adjustments are found necessary to protect vegetation, the land, and his other assets.

Frequently in the Southwest a year of maximum precipitation will have 10 times more rainfall than that which falls in years of lowest precipitation. This is shown in figure 1. Several years of below-average precipitation may follow successively, and this often gives rise to a prolonged period of drought. Conversely, a period of several years above normal precipitation may precede or follow a drought period. Carrizozo,

in central New Mexico, had an annual rainfall for the 22-year period, 1908 to 1929, inclusive, averaging slightly more than 9 inches. This was followed by a 10-year period averaging nearly twice as much. In every year of the 8-year period, 1926 to 1933 inclusive, precipitation was above the average of the previous 22 years (fig. 1). Records from Willcox, Ariz., show 14 consecutive years, 1891 to 1904 inclusive, with an annual rainfall materially below average (fig. 2) and followed by a period of heavy rainfall. It is particularly significant that during the last decade but few places recorded higher-than-average rainfall in the western United States. Willcox, Ariz., is one of a few western locations where average precipitation for the past 10 years was higher than for any previously recorded decade. At Morgan, Utah (fig. 3), in common with much of the West, precipitation during the past decade has averaged lower than any previous similar period.

Local storms may cover the same area repeatedly throughout a season and yet practically miss other areas. Such areas may be less than a township in extent; often on the same ranch a part may be well watered while the remainder suffers from drought. Monthly precipitation varies greatly at any given locality. Precipitation at Carrizozo, N. Mex., was found to vary from zero to more than the total annual for low years. Yearly and seasonal changes of management on a ranch are necessary for good livestock and range management.

In varying degrees the vegetation responds to climatic

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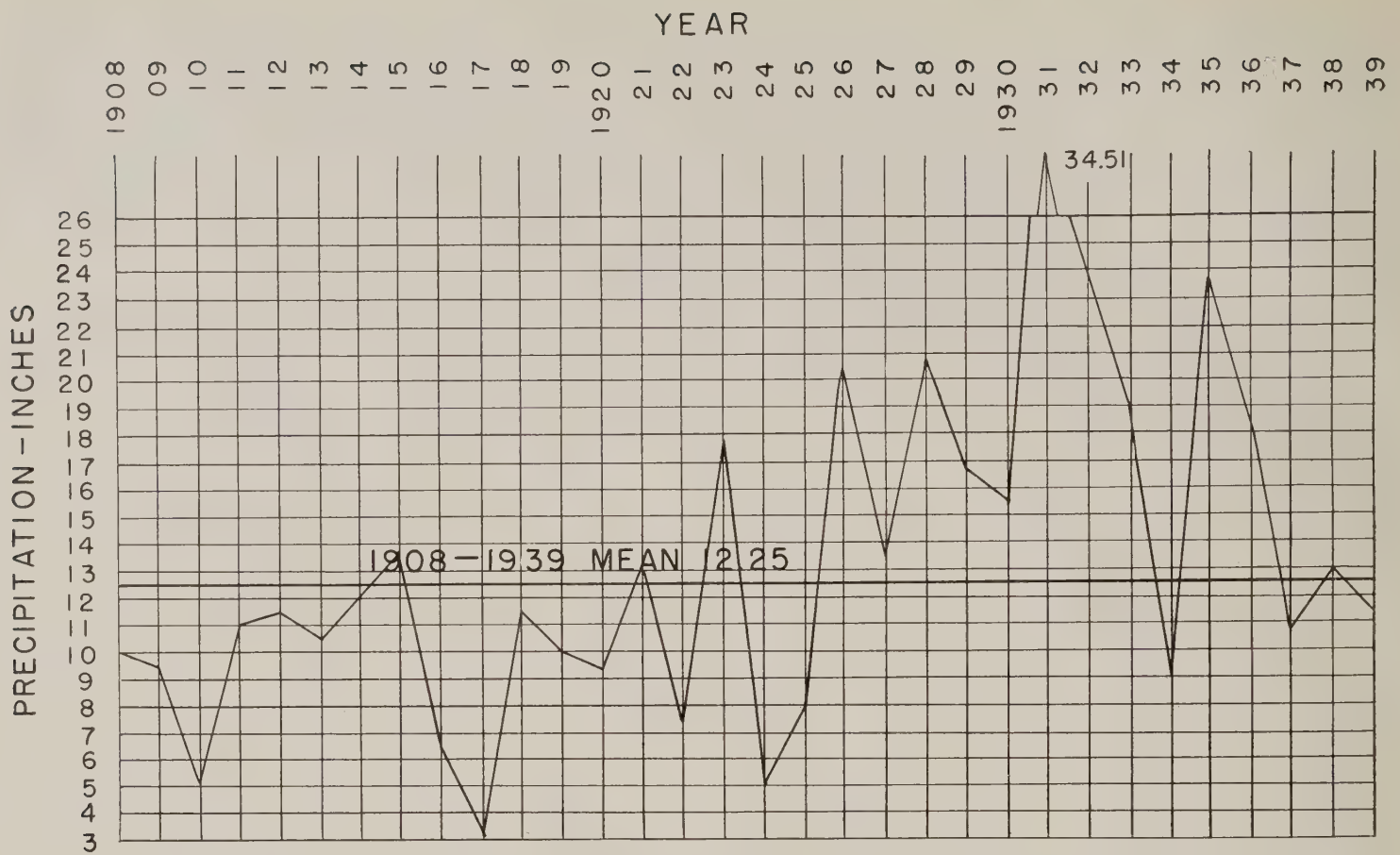


Figure 1.—Annual precipitation, 1908–39, Carrizozo, N. Mex. Two general cycles, and important fluctuations within each, are to be noted: First, average or below; second, average or above.

variations.—Soil moisture is the limiting factor to plant growth in the Southwest. Generally the amount of plant growth or forage production agrees rather closely with the amount of annual precipitation, but the character of precipitation, its seasonal distribution, and the vigor of the vegetation as influenced by the rainfall and use during preceding seasons, may influence forage production as much as does the total rainfall.

Records in central Utah where precipitation and forage production data were both available (fig. 4) show that the precipitation for any year did not vary more than 20 percent above or below the average for the period, but that during this same time forage production varied from 46 percent below average to 50 percent above average. Extreme as climatic fluctuations have been shown to be, forage production varies still more, and the departure from a recorded average may continue as long as there is a departure from the average in precipitation.

Severe drought results not only in little or no production of forage, but it may also decrease the grass stand. Generally there is a fluctuation in either composition or density of the vegetation in a series of years. Permanent injury may be caused by drought on an overgrazed range, but on a properly used range, even though material reduction in density may take place during drought, recovery of stand is rapid with

increased precipitation. The drought-thinned stand on a properly used range will produce a high forage yield upon return of favorable climatic conditions, even before recovery of the stand, because of the large volume growth of vigorous grass plants with little competition.

Forage use is a limiting factor in forage and livestock production.—Forage production may be reduced greatly by the climate, but it may be affected or its reduction accentuated still more by overuse. Forage production at Willcox, Ariz., and Carrizozo, N. Mex., in common with most of the West, has been low during the past decade although the precipitation has been relatively high. As in other locations, this has been laid to drought which has been general. However, the precipitation at these two locations has been above average for the past decade. Decline in forage production was due largely to overuse.

Density of black grama decreased in some New Mexico areas (8)³ as much as 89 percent in a single year of drought. During 1934, in western Kansas, 74.8 percent of short grass plants were killed on overgrazed pastures, and 64.6 percent on those moderately grazed (9). During the same year, in Arizona, grass density declined 70 percent on lightly used pastures, but was completely eliminated on heavily

³ Italic numbers in parentheses refer to publications listed at the end of the article.

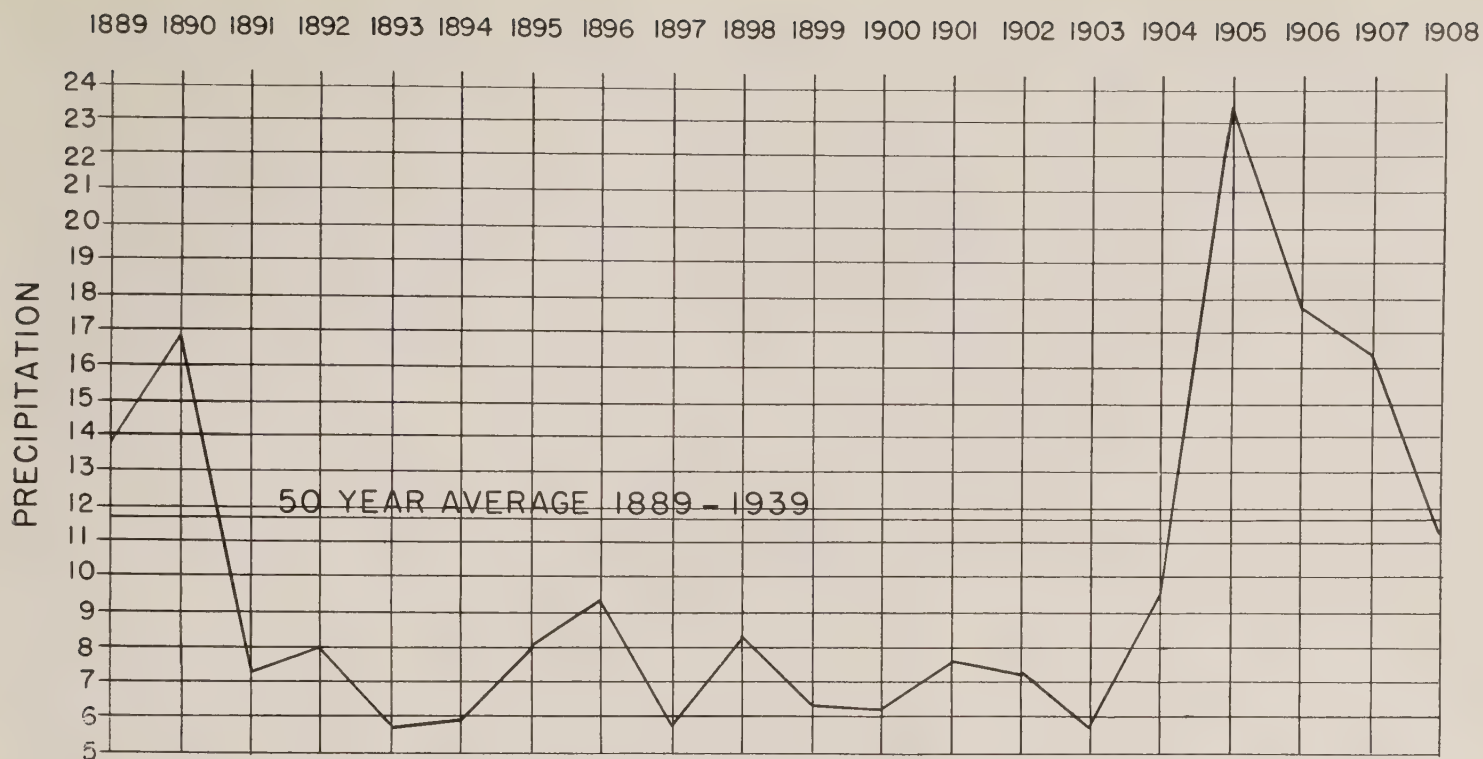


Figure 2.—Annual precipitation, 1889–1908, Willcox, Ariz. Two periods of more than average precipitation occurred within the 14-year period of drought.

grazed ones (4). Continuous close removal of the food-manufacturing leaves of the grass plant so starves it and uses up its reserve food that finally the plant's root system is shortened and its size and vigor reduced. Grama grass plants, weakened to the extent shown at the right in figure 5, may succumb in severe droughts. The ranges from which a large part of the grass stand disappeared in 1934 were populated by such weakened grass plants.

In Idaho it was observed during the period 1924–32 that forage fluctuated, under heavy and continuous spring and late fall grazing, in accord with favorable and unfavorable growing conditions the first two years, but the productivity of the pastures declined consistently thereafter in spite of some very favorable years. At the end of the experiment a reduction of 20 to 65 percent in grazing value was measurable (2).

It has been shown experimentally in some localities that the grazing of black grama to 2 inches will reduce the forage yield by one-half in 3 or 4 years and practically to zero in 8 or 9 years. Tobosa, clipped to 4 inches, yielded 110 percent more total forage in the 11-year period, 1924–35, than that clipped to 2 inches; vigor and stand were reduced on the 2-inch clipping so that the 4-inch clippings yielded 11 times more forage during the last 4 years of the experiment than the shorter clipped plots (1).

All parts of the grass plant—roots, stems, and leaves—play an important part in soil and water conservation. Recent work indicates, however, that volume growth of top parts has a much greater effect

than does vegetal density in reducing run-off and increasing percolation of water into the soil. Also, it is indicated that volume growth of plant tops and vegetal debris on the soil surface have a greater effect in reducing run-off and increasing percolation of water into the soil than do the combined effects of degree of slope, previous moisture content of the soil, and rate of precipitation (3).

The limitation of use of forage by livestock for a properly managed range therefore may be considered to be the time and degree of use beyond which plant vigor is penalized, run-off and erosion induced, percolation of water lessened and, as a result of the foregoing, forage production materially reduced.

Overuse of range penalizes not only forage production but the returns from livestock as well. Although range forage is fresh or cured feed stored on the ground, it represents as definite an amount of feed as hay stored in a stack. If too many livestock are grazed on it, there may be little more than enough for maintenance, whereas there ought to be sufficient feed for each animal to maintain itself as well as additional feed to be accounted for in either increased body weight or weight in calf or lamb production.

On semiarid grassland areas of light forage production capacity, having only 8.5 inches annual precipitation, good management that provided for plant vigor and plenty of forage (full feed) for the cattle has been producing 1,000-pound cows, with a 90-percent calf crop, the calves weighing 400 to 450 pounds at 7 to 8 months of age (7).

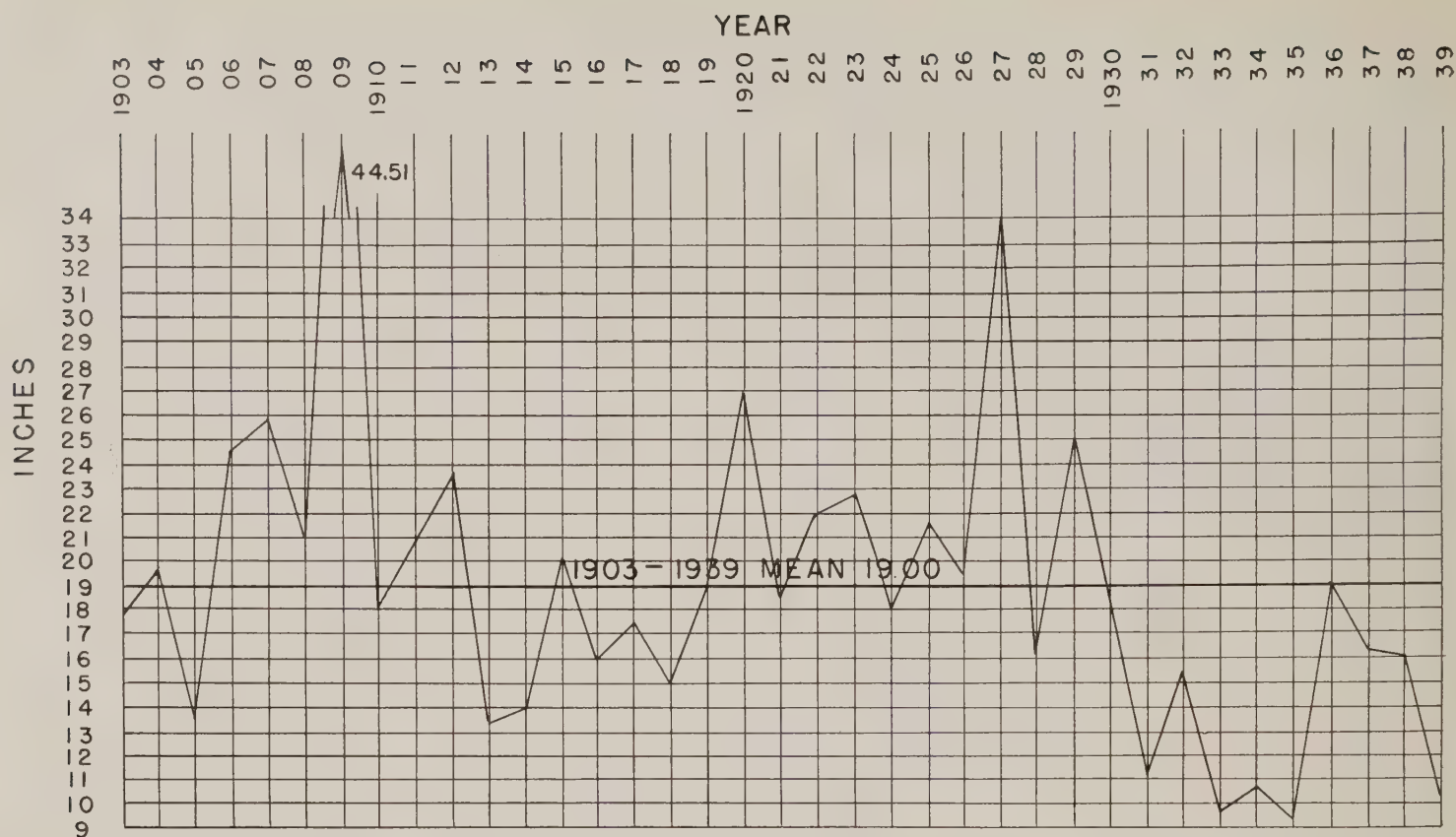


Figure 3.—Annual precipitation, 1903–39, Morgan, Utah. Observe the periods of fluctuating rainfall, particularly the low precipitation of the last decade.

Cows receiving 30 percent less feed, on poorly managed ranges, reach a mature weight of only 750 pounds with a 50-percent calf crop, the calves weighing only 320 pounds at 7 to 8 months (6).

On a straight poundage basis, in the first case, 1,000 pounds are being maintained for 360 to 400 pounds of calf. Approximately 73 percent of the feed is being used for maintenance. In the case of the 750-pound cows, with a 50-percent calf crop, 1,000 pounds are being maintained for 203 pounds of calf, and 84 percent of the feed is being used for maintenance.

The importance of good breeding is well known, but the mature weight of range cows and their productivity is influenced more by feed than by breeding. Well-managed ranges with plenty of feed are producing heavy cows and big crops of heavy calves. Overgrazed ranges with a shortage of feed are producing light cows and small crops of light calves regardless of how well bred the stock may be.

The objectives in range forage management are five-fold.—Proper range forage management is determined by the amount of grass growth or other forage that should be left on the ground to (1) conserve soil and moisture, (2) maintain plant vigor, (3) help in restoring a desirable vegetative cover on depleted and denuded ranges, (4) maintain an effective stand on range in good condition, and (5) maintain maximum forage produc-

tion which in turn results in maximum livestock production.

No specific procedure for making adjustments in forage use can be given to fit all parts of the country, or even different ranches within a given area. A few general principles, however, should be applied universally in range livestock management, such as (1) timely adjustments, (2) "full feed" on range from a range forage standpoint, (3) recognizing the opportunity of taking advantage of forage variations by livestock adjustments, and (4) providing the reserve feed that is necessary and sufficient to carry the livestock until the next regular shipping season, thus cushioning the effect of a possible delay in new growth or periods below normal production. Range-utilization and forage-production checks (5) are being used in the Southwest Region to guide the application of these range and livestock management principles.

Range-utilization and forage-production checks involve considerable planning as to methods and time and variations as to local conditions.—These checks will vary as to time and somewhat as to manner of application in different parts of the country. It has been found, however, that field men are able to make great progress in teaching the recognition and soundness of timely adjustments when forage production varies to the extent that sound economics and the objectives of soil conservation cannot be reached with the con-

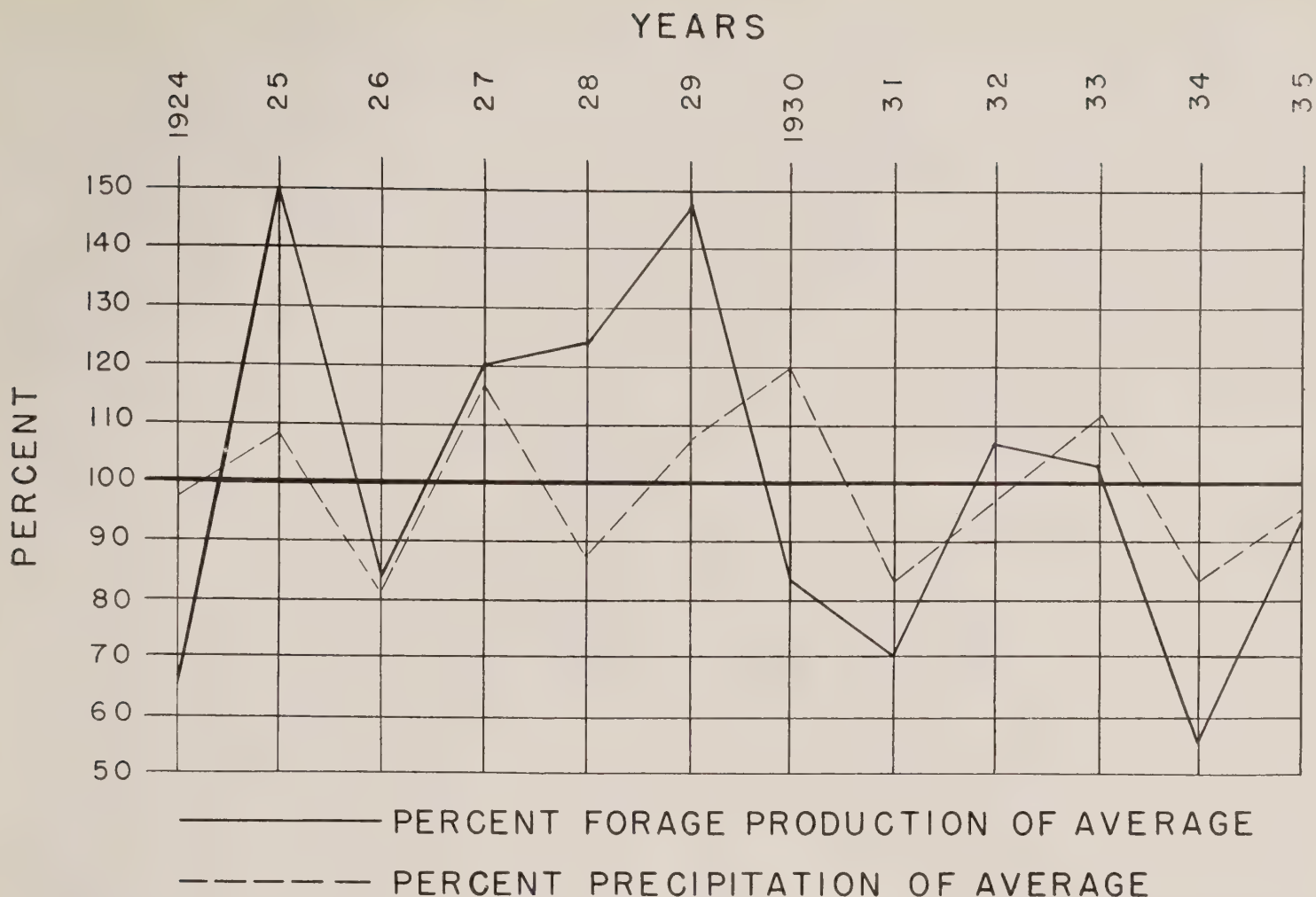


Figure 4.—Forage production and annual precipitation; annual deviation from average for period 1924–35. Forage production is seen to fluctuate between wider limits than precipitation. (*The Western Range*; Senate Doc. 199, p. 144; Weather Bureau records.)

tinuance of a set number of livestock or a prescribed plan of use.

Two checks should be made on most ranges, one in the fall and the other at the beginning of the growing season. However, one check may suffice or be more desirable, depending on whether the ranges are year-long or seasonal. The key time for taking stock of forage and feed resources is generally in the fall of the year after the growing season. At that time an analysis can be made of the approximate percent of forage that has been used during the summer months and the amount of forage still available. This feed may be not only the forage on the ground, but also that which is harvested, such as hay or ensilage. If it is apparent that the holding of the present number of stock will use up not only all the growth of the most palatable species but also some of the less palatable ones, and that such use will definitely damage the range, adjustments should be made immediately, either by securing more feed or by reducing the number of livestock in accordance with the available feed.

On ranges that have been used seasonally, it is well to make an analysis of the degree of past use and compare it with the records of stocking to help in planning

future management. The fall check on year-long ranges is valuable in a similar manner for analyzing effects of use to date and in projecting or planning needed management adjustments.

A second check at the beginning of growth on year-long ranges will supplement the fall check and further aid in adjusting management to conform to proper use. Additional casual but frequent inspections of pastures, livestock, and condition of the entire ranch are essential to successful livestock and range management, just as they are essential in any business. Many things can happen to vary conditions considerably, and one should be on hand to recognize and grasp the significance of such changes.

Stockmen are accustomed to work with these three elements: *time*; *numbers of livestock*; *percentage of feed used or left in the management of their ranges*. These factors should be considered when utilization and production checks are made. Where the Soil Conservation Service is assisting the operators to bring about better land use, Service range men should cooperate with ranchmen in making forage utilization and production checks, since joint participation will result in better understanding and accomplishment.

Livestock men always have made adjustments, but generally downward adjustments have not been made soon enough. The fact that numbers of livestock have been carried at a given level does not mean that a sacrifice has not been taken on weight or other production during low forage production years. On the other hand, when there has been increased forage production over any period of time, it has generally been used. Thus, the downward livestock adjustments were not drastic enough or made soon enough to protect either the livestock or the forage resources.

It is believed that needed or desirable adjustments in livestock numbers in a large part of the West should be made in the fall, and that corrections should be made to extend until the next regular shipping time. This does not mean necessarily that each pasture will have left on it an equal amount of feed; it means instead that some rotation or arrangement should be followed whereby dependence for feed is based on stored feed, or on old growth on the ground even though it is of poor quality, rather than on a problematical forage growth which may be delayed. A selling program may be followed if found desirable, although if livestock is held until the fall shipping it may be advisable to add supplements, especially if available forage is old and unpalatable. The extent of such changes and adjustments depend, of course, on locality and the type of operation.

Checking is necessary to supplement the grazing capacity estimate.—Proper management of ranges, as before stated, is dependent upon maintaining livestock on full feed, maintaining forage production at a high level, and conserving soil and moisture resources. It has been the practice to advocate that these objectives be attained by stocking ranges at a sustained grazing capacity. This sustained grazing capacity is set by some agencies at various percentages below the average forage production of the range as determined by range surveys. But this average forage production is very difficult to establish with any degree of certainty, and, if correct, might not be the best figure to use as a base for any given year.

Grazing capacity arrived at by a survey represents an estimated average and is valuable as an indication of relative grazing values over different parts of the range, or of one range with another. Owing to fluctuation in forage production, it must be recognized that for any given year the actual stocking may vary above or below the average grazing capacity estimates. No change in stocking for the ranch as a whole need be made, however, if, within reasonable limits of error, the estimated usable forage at the end of the forage

production period will support the number of animal units being carried.

In the Southwest, high densities of weakened blue grama stands are commonly encountered on overused ranges. Heavy use has shortened and restricted the root systems and the size of the grama grass plants until they do not utilize all the growth factors of the habitat. Thus, invasion of the intervening spaces by other species is possible, or by additional grama plants, largely by division, but these also remain small and weak due to overuse and competition. Such ranges make very little growth under the most favorable climatic conditions, and when proper use is initiated years are required before the density is sufficiently reduced by death of the weaker grama plants to allow the original cover to increase in size and vigor. Not until this stage is reached is there possibility of appreciable volume growth. Some exclusion plots began to show such changes and response within 3 years; others have had no use for 6 years and the only change yet apparent is a slight decrease in density. The vigor of the remaining plants has not recovered sufficiently for an increase in volume growth. Generally some use of grass is preferable to no use, but recovery of some such ranges may be slower with use than with nonuse. While this condition is most apparent on blue grama grass ranges, the same condition also is true of many other grass types.

When density, palatability and composition have been accurately determined, it has been found in one instance⁴ that a forage acre requirement determined under actual use and climatic conditions should have been as much as three or four times greater because of the inability of the grass stand to produce volume growth. In this instance an adequate cut had not been made for low vigor in first arriving at the forage acre requirement.

The number of forage acres may vary considerably in different years on the same range, and under the present method of surveys it is difficult to know how far an established figure of forage acres has departed from an average. For example, stocking on a grazing capacity estimate made 10 years ago at Carrizozo would have resulted in unused feed during the past 10 years. However, there would have been some advantage to soil conservation. It was determined experimentally upon range land not far from Carrizozo that actual grazing capacity based on yearly forage production varied from a high of 3,102 animal units in 1915 to a low of 738 in 1934, the average being 1,900 animal units. The variations in percent were 63 above and

⁴ Test made in collaboration with other agencies under approved methods of establishing forage acre requirement in such types.

61 below. Also, past use records may have been taken for a period that was either above or below the average grazing capacity.

In another instance (Morgan, Utah), the average annual precipitation for the decade 1920–29 inclusive was 22.34 inches. During the past decade, 1930–39 inclusive, it was 40 percent lower, 13.55 inches. Had the ranges been stocked on a “sustained grazing capacity” to the extent of 40 percent below the “average carrying capacity” as determined by a range survey in 1929, there still would have been too many livestock and probably permanent injury to the ranges, since the average precipitation for the 5-year period, 1931–35, was 50 percent below that of the preceding decade.

After harvest, the farmer who feeds livestock counts his tons of hay, ensilage, corn, or whatever feed he has produced and makes his plans until the next harvest accordingly. If he has a bumper crop, he will feed more stock for a longer period and carry over a little reserve feed beyond the next harvest season as provision for a possible low-production year. In the event of a poor crop, he should reduce his livestock to fit the available feed. The many successful ranchers who operate on the basis of adequate feed reserves on the ground to carry their livestock to the next regular selling period, without depending on a new growth which may be late or not materialize at all, are following the same general principles.

Since range experiences and investigations have shown that forage production varies widely, and that livestock adjustments need to be made often, the following possible adjustments are suggested:

1. Sell early enough to assure sufficient feed to carry over a substantial portion of the breeding herd. One-fourth of a total 50-percent reduction can be accomplished by selling certain classes of livestock 6 weeks early.

2. Sell cattle whose meat value is near their true value, such as steers, yearling heifers, calves of acceptable market age, fat dry cows.

3. Sell weaned calves, old, crippled, and excessively thin cows, all of which would be unduly expensive to carry over.

4. Sell heifer calves and yearling heifers that would not contribute to the building up of the quality of the herd.

5. Sell inferior breeding cows, shy breeding cows, and old cows expensive to carry over, and of little or no value.

Reductions such as these, in accordance with the degree of necessity and urgency, generally can be made

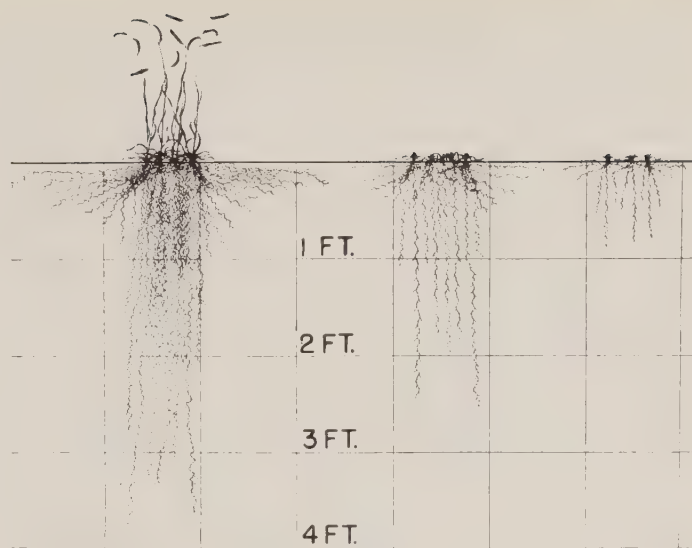


Figure 5.—Root and top development of blue grama grass resulting from different degrees and methods of past use. Left, plant in full vigor, full forage production; middle, low vigor, low forage production; right, depleted vigor, no production.

in cattle ⁵ numbers to fit years of low forage production with a minimum disturbance of the basic breeding herd, and with maximum protection to the rancher's income and economic stability.

Applying the above principles to reduction on a 100-cow ranch with 5 bulls, 20 or more heifer calves, and approximately the same number of 2-year-old heifers kept for replacements, where the calf crop is 80 percent, death loss of breeding cows 2 percent, culling of long yearling heifers 10 percent, culling of cows for unsoundness and nonbreeding 2 percent, and with sale of old cows at 9 years of age, a 50-percent reduction can be made in the total number of animal units, leaving intact approximately two-thirds of the normal cow herd consisting of the very best of cows from 3 to 6 years of age.

Under the same conditions on a ranch where most of the steer calves ordinarily are carried over and sold as yearlings, a 50-percent reduction can be made in the total number of animal units by disposing of the classes of stock mentioned above, thus leaving intact approximately 75 percent of the normal cow herd consisting of the very best cows from 3 to 6 years of age.

Diligence in taking forage inventory in low production years and in making sales promptly usually will preclude greater reductions than shown in the two preceding examples. In years of extremely low forage production, it may be necessary to make still further reductions in the breeding herd although this rarely will be necessary if management is projected ahead by timely adjustments. In the case of adjustments that

⁵ Cattle have been used throughout this paper to illustrate principles. Other kinds of livestock may be handled with limitations peculiar to the kind, according to the same principles.

are delayed until all feed is used in the hope that the stock will live through, the outcome may be the sacrifice of a very large part of the breeding herd at a ruinous price, in addition to the total loss of many through starvation, and a serious handicap to future forage production by overuse. Under proper management, involving timely adjustment to fit forage production, adjustments need not be frequent and are much less disastrous.

In years of high forage production the numbers of livestock may be increased by keeping the steer calves another year, and, if necessary, increasing the cow herd by retaining more heifers or buying. Generally, steers may be kept with extra profit; it has been demonstrated by tests under Southwestern semiarid range conditions that a given pasture will produce more on a yearling-steer basis than with a breeding herd on a cow-and-calf basis.

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NATIVE PLANTS STABILIZE POND SHORES

BY BEN OSBORN¹

BY PROTECTING native plants around a pond, the Service and a cooperating farmer, in three seasons, succeeded in completely stabilizing the shores and inlet channel. Now neither waves nor inflowing water can pick up soil and carry it into the pond. At the same time, nesting sites were created for birds and

also a suitable stopping place for migrating ducks. A fence constructed around the pond at the time it was built excluded livestock and made possible the establishment and development of the vegetation.

The dam was built with emergency drought-relief funds in the late summer of 1936. The site was a draw through a native prairie pasture on the farm of E. R. Sherwin, near Elk City, Okla. At that time the

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Amphibious herbs at water's edge at upper end of pond, with willow, buttonbush, and sloughgrass beyond.

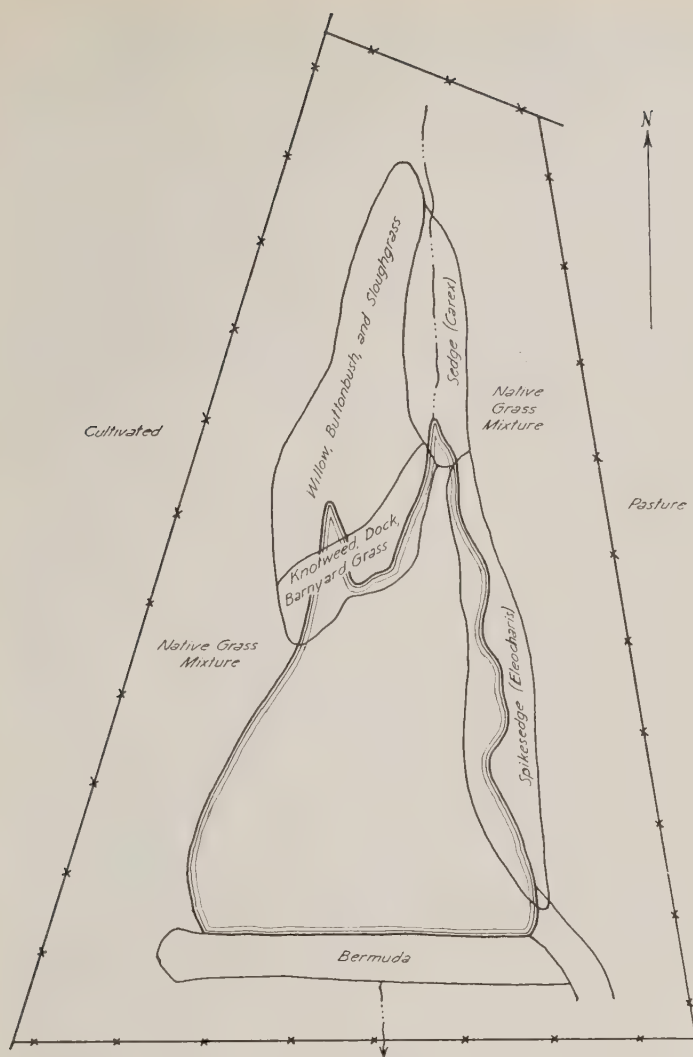


Diagram of vegetation around pond.

cover was badly exhausted by months of drought and continued use by hungry livestock.

The dam and spillway were sodded to Bermuda grass in the fall following the construction. With livestock excluded from the shores, natural vegetation was promptly established on the rest of the enclosed area. Various kinds of native herbaceous and woody vegetation, each in its normal relationship to the water, soon covered the area within the influence of the impounded water. The rest of the fenced area grew up to a mixture of native grasses, including switchgrass (*Panicum virgatum*), little bluestem (*Andropogon scoparius*), sideoats grama (*Bouteloua curtipendula*) and blue grama (*Bouteloua gracilis*).

By the fall of 1939 a native species of sedge (*Carex*) had formed a perfect mat of vegetation in the inlet channel to the pond. This cover was capable of carrying without damage the inrush of water during the occasional torrential rains characteristic of the plains country. A mixture of willow (*Salix*), buttonbush (*Cephalanthus*), and sloughgrass (*Spartina pectinata*), grew on the low-lying ground at the upper end of the pond. Within the zone of usual fluctuation of the normal water line, and in the shelter of the taller

vegetation, a mixture of amphibious herbs, principally knotweed (*Polygonum*), dock (*Rumex*), and barnyard-grass (*Echinochloa crus-galli*), became established.

One side of the pond site was a gentle slope that allowed for a wide lateral fluctuation in water line. A species of spike sedge (*Eleocharis*), capable of withstanding occasional inundations as well as long periods of exposure, developed here. It completely covered this critical shoreline, reaching from below the water's edge to the grass cover above the high-water line. The slope of the other side of the pond was abrupt, and the native grasses grew down to the water's edge.

In the summer of 1940 the vegetation around this pond already was being used as a nesting place by birds. Redwing blackbirds occupied the shrubs and tall sloughgrass cover at the upper end of the pond. Meadowlarks nested in the grass around the pond. Mourning doves used it as a watering place, and kill-deers, Arkansas kingbirds, scissortailed flycatchers, grackles, and other birds were regularly present during the summer.

The only vegetation established by man at this pond site was Bermuda grass. The other vegetation was established naturally, a process which ordinarily will be duplicated in the Oklahoma prairie area wherever similar protection is given.

P. E. Neale, of the New Mexico Experiment Station, reported that two groups of range cows, of 78 and 116 head, respectively, had equal quantities of feed. The group of 78 cows, having an average ration of 21 pounds of feed, produced 28,000 pounds of calves, while the group of 116 cows, given an average ration of 14.3 pounds of feed, produced only 9,000 pounds of calves. In the case of the group of 78 cows, there was a 90-percent calf crop and the gross return per cow was \$28, while in the group of 116 cows there was a 30-percent calf crop and the gross return was \$6 per cow. It is very apparent that range cows must have practically full feed of the forage commonly produced on the range in order to produce a big crop of good calves at weaning time.

Indians of other days were largely responsible for the great grassland plains of the Southwest, according to W. G. McGinnies, ecologist for the Southwestern Range and Experiment Station at Tucson, Ariz. The early American red men, afoot and unable to catch the fleet game of the plains country, used the device of setting fire to the grass to drive the animals into the woods where they could be stalked with more success. Had it not been for these fires, much of what are now grasslands would be covered with forests.

FIVE YEARS OF TREE PLANTING IN THE OHIO VALLEY

BY J. A. GIBBS ¹

DURING the last 6 years the Soil Conservation Service has replanned for erosion control more than 8,000 farms in the Ohio Valley Region. On most of these farms small woodland plantings have been established. The observations reported in this article are based on the planting of many millions of seedlings and transplants, and the practice of direct seeding under widely varied conditions.

What are the results? Have these new tree plantations survived? What species of trees are the best? Has erosion been controlled? Can other farmers successfully reclaim eroded areas on their farms by planting trees?

After five full growing seasons—together with the results of forestry research—some of these questions can be answered, and the follow-up observations of the erosion-control demonstrations permit certain recommendations. A wide range of species, methods of planting and of site treatment have been tested and observed.

A study of a great many of the adapted plantings and methods points out very forcibly the importance of the principle of "minimum requirements," the chief concern of the average farmer in approaching his tree planting problems. He very logically wants to know and needs to know what are the simplest and lowest cost requirements necessary and adequate for his particular area and set of conditions, to bring about the desired results within a reasonable length of time.

Early erosion-control plantings consisted chiefly of black locust. This was due to a partially mistaken belief that black locust would thrive under any conditions and, also, to the relative ease of providing ample planting stock. In the 1935-36 plantings, 79 percent of all trees planted in the Ohio Valley Region (Michigan, Ohio, Indiana, Kentucky, and Tennessee) of the Soil Conservation Service were black locust, 13 percent were other hardwoods, and 8 percent were pine. In general, seedlings and transplants were used, although a small amount of direct seeding was done also.

Since that time however, a gradual change has been brought about in the ratio of black locust to pine and hardwood species. In sharp contrast to 79-percent locust and 8-percent pine planted in 1935-36, only 35

percent of the trees planted in 1938-39 were locust and 52 percent were pine. There also has been a decided trend away from so much gully planting. Instead, more and more of the planting has been done on eroded fields as may be noted in the following table:

Table showing trend of tree plantings, 1934-39

Plantings	1934-35	1935-36	1936-37	1937-38	1938-39
	Percent	Percent	Percent	Percent	Percent
Black locust	83	79	60	42	35
Pine	14	8	13	27	52
Hardwoods	3	13	27	31	13
On fields	21	29	63	71	86
In gullies	79	71	37	29	14

In establishing most of the earlier stands the grub hoe for scalping and the center hole method of planting were used in fields. In planting gullies, banks were sloped and check dams of varying types were put in. Fertilizing of black locust, particularly in Indiana, and also mulching were employed in some locations. Contour furrowing and ridging were used in 1937 and 1938.

On some sites contour furrows and ridges proved advantageous in facilitating planting and in checking erosion, but the variable results do not justify general recommendation of this method of site preparation. Under certain conditions the furrows filled up completely within a period of 2 or 3 months, while on other sites heavy vegetation developed between the furrows when the areas were protected from grazing and this greatly minimized the water-conserving benefit of the furrows. On certain soils, too, the furrows and ridges have not served to stimulate growth. Low cost fertilizing of individual trees has given good results on some soils, especially in Indiana, and the practice is now being tried in other parts of the region. A tablespoonful of fertilizer per tree applied to black locust at the time of planting stimulates initial growth of backward trees.

In view of both costs and results obtainable, there appears to be little justification for the sloping of gully banks in tree planting areas intended for permanent woodland. In the Ohio Valley plantings, the trees have survived and grown well on very steep unsloped banks. Encouraging results also have been obtained from plantings above and below vertical gully banks. Obviously, we may expect that stabilization will be

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Loblolly pine planted as 1-year-old seedlings in 1934 on Atwood fine sandy loam. Before planting the area was plowed; lespedeza was sown. This fine survival has attained a maximum height of 13 feet.

delayed where the banks are not sloped; but on the other hand the average farmer can better afford to wait for desired results than to make the outlay for sloping operations.

Live check dams formed by planting rows of trees a few inches apart across the bottom of gullies have been effective. Wider use of readily available, local, adaptable species of both trees and shrubs can be recommended for this method of stabilization. Pine, black locust, and willow were originally used in living check dams; more recently, however, there has been a trend toward using almost any native, readily available plants such as buck brush, broomsedge, blackberry, etc. The use of both the trees and shrubs represents very little labor or other cost. The usual method of establishment is by planting two rows of plants in a prepared "shovel-wide" trench across the

bottom of the gully. The plants are spaced 3 to 8 inches apart in the row. On the basis of the costs and the benefits derived from mechanical check dams (stone masonry, concrete, wood slab, wire, etc.) such structures cannot be justified for gully control in tree planting areas.

Mulching of gully heads and other critical and poor sites has produced results that seem to justify broader application of this practice where mulching material can be obtained close at hand. Material such as broomsedge lifted with the roots, straw, and fine brush have proved very effective. Mulching has been observed to stimulate both survival and growth and also the occurrence of volunteer vegetation. Mulching also lowers surface temperatures: In western Kentucky, during August afternoons, soil temperatures of the top half-inch of Grenada soil ranged as high as 140° F. on unmulched areas of southern exposures—this in contrast to not over 90° F. on comparable mulched areas.

Observations covering a wide range of soil conditions and common species show that soil types and soil conditions constitute the first and most important consideration relative to a decision as to what and how to plant. Proper correlation of species and sites largely accomplishes satisfactory establishment and growth, at minimum cost. In the 5 years of tree planting there was much evidence to indicate that where the proper species had been used for the site involved, very little site treatment was required aside from protection. Likewise, where the wrong species had been used, elaborate site preparation had not stimulated growth.

The results of these plantings indicate that direct seeding of light-seeded hardwoods offers considerable promise of satisfactory establishment under favorable soil and site conditions. Direct seeding of such species as black walnut has not been encouraging, chiefly because of removal of the seed by rodents; but on the other hand good results with other species, using this low-cost, simple practice, point out the importance of continued effort toward solving the rodent problem. The practice of stratifying such seed as walnut and oak, followed by spring planting, minimizes loss by rodents. Observations seem to verify the opinion of many that there are several distinct advantages in using the seed instead of seedlings of such taprooted species as black walnut. Among other difficulties in connection with the use of seedlings, some root rot has been found to occur in the heavy taproot where it was severed in lifting operations. With black walnut seedlings, producing taproots as long as 50 inches the first year, it is hardly to be expected that more than a

small part of this root will be preserved in lifting. In using light-seeded species, such as tulip and ash, broadcast seeding is considered preferable to seeding in prepared spots, as it results in better distribution. For the average farmer there need be no cost for direct seeding, provided, of course, he is able to collect desirable seed on his or neighboring farms.

In the treatment of the old established but neglected woodland areas, protection from livestock has been the first essential measure throughout the five years of the Ohio Valley plantings. This protection alone with no additional treatment or planting, has resulted in the appearance of literally thousands of woody plant seedlings per acre within a period of 2 to 5 years. This represents the simplest, the least expensive, and generally the best method of reestablishing an effective and profitable cover in old woods. Observations over the past 5 years indicate that under many conditions, protection and the presence of seed trees are sufficient to bring about natural reproduction and reestablishment of a satisfactory stand. The farmer and the forester in the Ohio Valley are both alert for these favorable conditions—conditions which if present will eliminate the necessity of costly and hazardous tree planting.

There are many areas, however, where the original soil conditions, which once supported native hardwoods and would now be favorable for natural reseeding, have been completely changed as the result of erosion. These areas are characterized by serious sheet erosion and all too commonly by gullies. Under such conditions, artificial establishment of cover becomes advisable in order to provide an effective stand for erosion control and to afford economic benefits. The chief problem on such areas has been what species to plant, since in the first place, these eroded lands include a wide range of soil and site conditions, and second, because it is desirable to bring about the best results in the shortest period of time.

Abundant evidence indicates the importance of using pioneer species on eroded soils. Hardwood plantings, including black walnut, tulip poplar, ash, maple, red and white and black oak, in all instances have failed to develop on eroded soils. While black locust often makes satisfactory growth under a wide range of soil conditions, consistent failures on some soils indicate the need for cautious selection of sites. Black locust has done particularly well on soils containing some calcareous material (lime) in the parent material; it has been found making remarkable growth in such soils as Princeton sand in Indiana, and in Brooke and Upshur soils in Ohio in both gully and field plantings. Failures

have been observed on some soils where relatively high iron and manganese concentrations were present. As an example, a 5-year-old plantation was classed as a failure on a Muskingum silt loam soil with purple shale parent material where the manganese content was found to be very high and where limestone was absent. Failures have occurred also on some of the cherty and coastal plains soils in Indiana, Kentucky, and Tennessee, both with and without elaborate site preparation. In one area in central Kentucky where cherty soils are commonly found in tree planting areas, failures of black locust are common.

In height growth, black locust has made up to an average of 4 feet per year over a 5-year period on the better locust sites. Over the same period, the most rapid growth of pine was found in western Tennessee where loblolly pine averaged about 2 feet per year. Of the northern pines, red and Scotch have excelled in height growth. Actual measurements of several 5-year-old plantations on one project in Ohio (Muskingum County) show an average total height of 4.7 feet for Scotch pine, 3.9 feet for red pine, and 3.4 feet for white pine.

Even though there are fewer pine plantations in which to check results, it is evident that generally they are more successful on eroded soils than black locust. Many successful pine plantings were observed on sites where black locust has failed.

Ordinarily a good ground cover of weeds, grasses, and woody seedlings was established in all plantations of 5 and 6 years of age. Under the black locust, considerable variation in the characteristics of ground cover was in evidence and in the more successful plantations either a leaf litter or bluegrass cover, or both, had accumulated. Natural reproduction of woody species was taking place in most of the locust plantations where observations were made; in 40 out of 55 five-year-old plantations studied, there was natural reproduction consisting mostly of such species as sassafras, black gum, dogwood, cherry, sycamore, soft maple, elm, and a few species such as red, black, and white oak, tulip, ash, and hickory. It was significant that where black locust had failed there was little, if any, ground cover.

With the exception of loblolly pine plantations in western Tennessee, no great amount of litter accumulation was found under 5-year-old pine plantations. In most instances, however, such plants as broomsedge, poverty grass and blackberry were found between the pine trees. The loblolly was the only species of pine that had begun to close and exclude the grasses and shrubs.

One of the major considerations in observing ground cover was to check the effect of plantings on erosion. In most of the areas observed, erosion had been checked materially by the combined effect of planted trees and the native volunteer vegetation—this was especially true where the trees had grown well. Although usually gully banks were completely stabilized in the course of 4 to 6 years, gully bottoms in some soil types were still active in varying degrees.

Aside from improper selection of species for sites involved, the most common cause of the failures

observed was grazing. A strikingly large percentage of the older plantings are not being protected from livestock; hogs, sheep, and cattle are gradually destroying many plantings where once were good survival and growth. Plantings were noted where trees had been almost completely destroyed by the browsing, rubbing, and trampling of livestock. Unquestionably, the most vital need in a farm forestry program in the Ohio Valley Region is an educational campaign to demonstrate to farmers the damage to young trees, both planted and native, from grazing by livestock.

FARM WOODLAND--FARM ECONOMY

BY JOHN F. PRESTON¹

SOIL conservation districts represent an attempt to provide the social machinery by which a democracy can save the soil resources essential to the continued existence of civilization. There are many reasons of self-interest for adopting soil-conserving practices, and many more that are largely community and national interests. The farm planner must appeal to both the inherent individualism dominant in all men and to the larger instincts of the common good. Since the parts of the farm dedicated to permanent use as woodland vary all the way from badly eroded land in need of reforestation to good producing forests capable of bringing in an immediate income, their successful incorporation into the farm organization involves the ideas of self-interest and profit and those of community and national welfare.

For example, let us consider national wood economics. We have about 140 million acres of potentially productive farm woodlands. If this potentiality could be converted into reality these forests could produce annually all the lumber used in the United States on the basis of averages for the past 10 years. This would be about one-third of our total wood requirements. This would mean cheaper lumber than consumers are getting now, and the income going to the farmer-producers would go a long way toward solving the problem of farm income on millions of farms. Perhaps farm woodlands should not be managed primarily for sawlogs, but the example cited serves to illustrate the point that both national interest and individual interest point to the wisdom of growing perhaps one-third of our national wood requirements in the form of poles, posts, pulpwood, sawlogs, and other products on farm.

To bring this about requires a change in farmers'

ideas of farm economy. It means acceptance of the idea of a productive woods managed as a part of the farm where a wood harvest in winter becomes as much a part of a farm calendar as a hay harvest in summer. Temporarily, such a change involves problems of marketing which will not exist when sustained-yield management becomes general. The marketing problem is acute largely because we have such an abundance of low-grade products, such as fuel wood, and a scarcity of high-grade products, such as poles and sawlogs. Wood-using industries have been forced, because of inability to buy suitable wood products from farmers, to seek other sources of supply and often to move out of agricultural sections. When good management practices on farm woodlands produce the products required by industries, in sufficient quantity to supply their annual requirements, there will be little difficulty in finding a market; wood-using industries will spring up where raw material can be obtained at satisfactory prices. Our present difficulty is concerned with the marketing of low-grade products, but the real problem is to produce high-class timber that will attract its own market.

At the other end of the economic scale are the lands dedicated to woodland use which are now producing nothing and may constitute erosion hazards. These may be worn-out fields with little or no cover, or logged-off land with only a brush cover. The self-interest of the farmer will prompt him to make such lands productive, provided he can see a reward for his efforts.

What is involved in the rehabilitation of such lands? Usually fire protection, nongrazing, planting stock, labor of planting, and sometimes cutting of brush, mulching, or other means of preparing the planting site, and perhaps weeding operations as the trees

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grow. Planting stock may be furnished free or at nominal prices by public or private agencies, or the stock can be grown on the farm. The nongrazing of such areas may entail some sacrifices of income, and some cash expenditures for fencing. The preponderance of weight in the list of things to be done, however, falls in the class of labor to be expended on the land. This is the farmer's stock in trade. It is what he markets when he sells grain or hay or livestock or wood products. Often he fails to get a fair labor return; rarely does he get a profit over and above labor. Much labor is expended on farms that does not promise an immediate return—for example, planting an orchard or a hedge row, mowing the lawn, growing flowers, painting the buildings, whitewashing the fence and tidying up the place. In the same category come numerous farm activities sponsored by the county agents and farm organizations. Perhaps more unproductive labor has been expended on clearing land inherently not suitable for clean cultivation than on most other farm activities. Restoring land to productivity brings its own rewards in future income, in increased capital values and in the satisfaction that comes from a job well done—a job which makes a better farm and helps to ensure permanence to our way of life. The job of rehabilitation of such lands can therefore be done if the will to do it exists.

What is the cost of rehabilitation of land? If men are hired to perform the labor, the costs can be figured. If the farmer becomes so interested in the job that he lets his hay spoil while he practices silviculture with an axe, the costs can be figured. But, if he puts in labor for which he has no other immediate market, he has made an investment which, if it returns something later on, is a sound investment. There is no cost for labor so expended, but there is a very certain though perhaps deferred labor return. In commercial undertakings, dividends on capital stock are not items of cost; they are only subclassifications of the returns, if and when the returns are large enough to permit dividends. The risk of losing the capital stock itself is always present in commercial enterprises. Many a corporation has made much worse expenditures of its money and had less return than the farmer receives when he spends his labor in land rehabilitation. The cost of restoring land to productivity, if carried on as a seasonal farm activity, cannot be figured by the usual methods of imputing cash values to unmarketable products.

Now let us return to the problem of management of existing farm woodlands. Foresters are taught to think in terms of stumpage—the net value of the wood crop as it stands in the woods. Farm economy is made

of sterner stuff. The way of life of the farmer, the rules of the game which he plays, contemplate no such easy way as selling a crop as it stands in the field. The rule of the farm is, as far as possible, to process the product on the farm and to transport it to market with the facilities of the farm. With the possible exception of a few highly speculative agricultural adventures, such as citrus crops, the commodity sent to market acquires value largely through the work of men, animals, and machinery.

The farmer who sells his wheat or cotton or corn as it matures in the field, or rents his pasture to his neighbors, is not following the precepts of sound farm economy and is probably headed for the rocks. Very few banks or insurance companies find it profitable to operate or rent farm land acquired through mortgage foreclosures. Very few agricultural speculators, whether the crop is wheat or tung oil or citrus, realize the promised profits of the promoters. Agriculture by remote control must be classed as highly speculative. Farm economy, which in the long run succeeds in producing a satisfactory income, is based on the growing, the processing and transportation of the products of the land, and, in the vast majority of cases, the end result is the translation of labor into salable products. The better farmers, through planning, good business management, building up of soil structure and fertility, and some luck, are able to get more than a labor return, which is the margin from whence comes interest on capital invested, or rent for the landlord, and perhaps a profit.

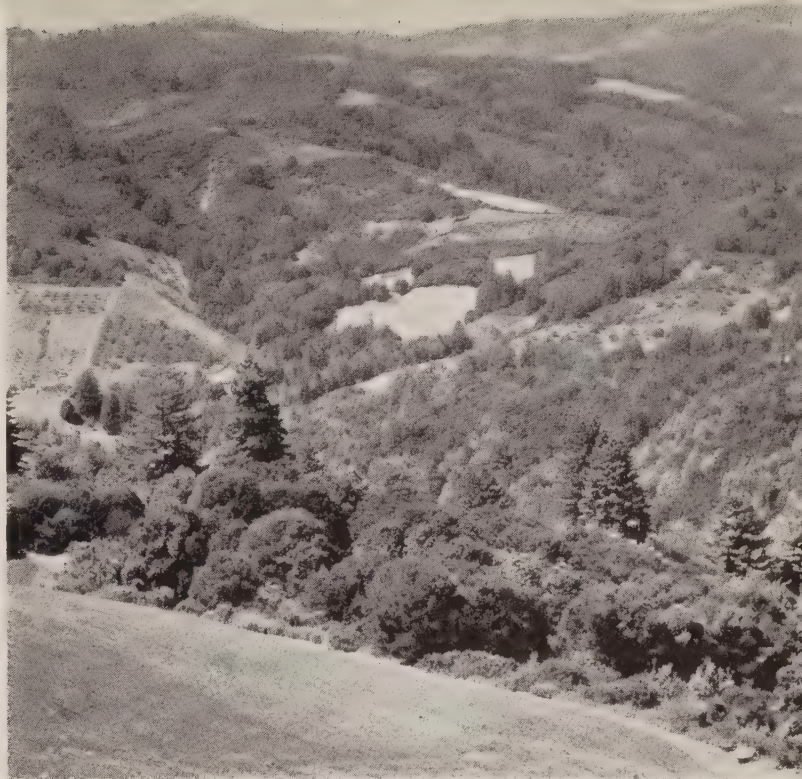
The "stumpage" of the forester has no place in farm economy, because the margin above cash costs is made up from all farm crops and the rubric of farm economy so ties all activities together that they are actually very difficult to separate. The fact that we still think in terms of stumpage only proves that the farm woodland is not being considered, or is not actually being operated, as a farm enterprise. The farmer plans his crops of corn, hay, wheat, with reference to the labor which he can put into them and with reference to the seasonal distribution of that labor. He plans to utilize nonscheduled time in mowing pastures, hauling and distributing fertilizer, building fences, clearing land, etc. If the farm woodland is actually included in his farm organization, he also plans his harvest of forest products with reference to his seasonal labor chart. The quantity of wood products removed is determined as much by his seasonal labor chart as it is by the market price of wood products or the calculated volume regulation of the forester. It may be good farm economy to cut less wood volume than the current growth even if the growing stock is nor-

mal, or it may also be wise to over cut temporarily in the woods with the expectation of either buying more acres of woods or of later diverting the woods labor into other farm enterprises.

One farmer, approached recently as a prospective cooperator on a farm forestry project, made a statement which showed clearly that his woods had never been incorporated into his farm organization. After expressing a willingness to have the forester examine his farm and his woods and see what forestry program could be worked out, he added these significant words, "But I am not going to give my timber away." When we examined his woodland, we knew what he meant. Part of his woods contained several hundred thousand feet of overmature, partly stag-headed timber. He has been waiting for probably 20 years to sell that timber to a logger and "cash in" on it. The price of logs or lumber in his neighborhood leaves no "stumpage" value. There is a labor return in it, however, if cut at the rate represented by his seasonal chart of available labor. If cut, skidded, and hauled to the mill in the winter with farm labor and equipment, the cash received would largely represent an actual increase in farm income with little additional expense.

If clean cut by a logger, as it would have to be, the cut-over area would become a fire hazard and very likely a "burn." The market for fuel could not absorb all of the tops and culls. If harvested annually over a period of 10 or 15 years, the logging waste could be sold as fuel, the fire hazard would be reduced to almost nothing, reproduction would be assured. Were this woodland actually considered as a part of the farm, farm economy would force its cutting even though no margin above the labor return was realized. The silviculturist would say that such a woods should be cut at once because losses exceed the growth, and it is therefore necessary that a young growing forest be substituted. From the standpoint of farm economy, however, all the arguments are in favor of a gradual removal of the crop. In this instance there was actually very little choice. This farmer could increase his farm income by taking the woodland into his farm business and cutting it as a farm crop. In the Big Hole Basin, in Montana, it used to be facetiously said that there were two seasons—haying and sleighing. This farmer could well recognize at least two important seasons in his farm calendar—haying and logging.

A farmer needs a variety of wood products, for his own farm business and to be in better position to take advantage of the varying demands of the wood market. Therefore, farm forestry should introduce on suitable sites new and promising, even exotic, species in mixture with the recognized standard species. If the



Farm planners consign to permanent woodland parts of the farm which vary all the way from eroded slopes and brush-covered wastes to good producing forests.

new ones grow and thrive, they will be favored; if they do not continue to show promise they will be removed in thinnings and no harm has been done. Thus farm forestry has a big advantage in this respect over agronomy or horticulture. For example, in western Oregon the farm woodlands are mostly Douglas fir, marketable for several products. There is a growing furniture market, based mostly on native alder and cottonwood of which some farmers have very little. It is good farm economy not only to increase the proportions of alder and cottonwood, but to introduce other trees, native or foreign, such as walnut, birch, maple, ash, beech.

Farm woodland management is a vastly different field from forest management. Farm planners in dealing with farm forestry problems should think in terms of farm economy as much as in terms of silviculture and forest regulation. Fuel wood in most farm woodlands is a byproduct and usually has a low value, a labor return only. Our objective should be to produce products which promise a margin above labor returns and take posts and fuel as byproducts.

At this stage in the development of the farm woodland as one of the farm enterprises, success depends largely on, first, a thorough understanding of how the farm woodland fits into farm economy and, second, on the ability of the farm planner to convince the farmer that he should change his concept of the farming business to include farm woods management as an integral part of it. This is a large order; but on it success in a farm conservation program largely depends.

USE OF BRUSH FOR EROSION CONTROL

BY R. E. WILSON ¹

EVERY farmer, rancher, lumberman, and forester agrees that where a limb or the branched top of a tree, or an old log, or the rusty flywheel of an old car is lying on the ground, the grasses or weeds grow a little thicker or taller as they come up through the branchlets, or along the edges of the board, or underneath the round of the log, or up through the hole in the flywheel. Why is this? It is because moisture is increased and retained after rains by any obstruction and protection on the ground. The same protection affects the plant temperature, whether it be heat or shaded coolness. Such an obstacle collects seed; and likewise it guards against the enemies of washing water and grazing animals.

If we extend this idea the results will gain in importance. It is told of many an old pioneer settler from back East, or Mormon farmer, that when he came to the new land he scattered a handful or so of tree seeds, flower seeds, or willow cuttings. It was said that he was introducing new species. Today we can attain a similar end by scattering a little brush here and there to aid in bringing back or increasing the plant cover on small worn areas that have been unwisely used over the years.

First, let us look at the business of procuring the brush. Softwood or evergreen brush, as a rule, is the best to use. In the Southwest, there is more of it (juniper, piñon, and pine) than of hardwood species. Oak or other broadleaved brush is also useful, especially to protect tree plantings; but coniferous brush provides a thicker body because of the needles, twigs, and larger stems, and by nature of its shape it lies closer to the ground where the first run of silt covers the needles and branch tips if tops are laid upstream or upslope. Conifer brush, particularly juniper, is more durable.

Brush from trees used to be cut in any manner, without thought as to whether or not the tree stands were injured. A tree was butchered or slashed and left in a more or less ruined condition, the main objective being to secure enough brush by the easiest method. Then, for stand improvement, the lower limbs of the trunk were pruned out. Thinning of a stand of trees and pruning still have their place in conservation, and the brush taken in the process is certainly to be used. Where the tree crown can be

opened up by the cutting of certain branches, and leaving the lower limbs to protect the ground from water or wind erosion, no harm results from such pruning. Proper pruning of trees and shrubs on range lands, combined with proper grazing control, affords additional benefits in the form of renewed grass cover and shade on certain soil types and slopes. Good sod and a thick grass cover provide the best possible protection against erosion. However, since any diminution of the tree foliage decreases proportionally the leaf surface, so essential to tree life and growth, and since any lessening of the tree crown may open a path to water or wind action, it may be safely said that too much cutting may be harmful, and the less cutting done the better.

Just as the lumberman is adopting what is called "selective logging" and is cutting more conservatively and thinly over a larger area, thus leaving the forest in condition for a later cut, so is the farmer adopting a method of selective brush cutting in his woodland. The fundamental principle may be stated thus: Thin or trim as conservatively as possible, picking around for the brush so as to spread the cutting among more trees, but cut no more than one-sixth to one-fourth of the crown from any tree. In this way, only that brush is cut which should be cut—old limbs or those from tree sections that are too thick—and the full size of the crown as a windbreak remains undiminished while at the same time light is let into the foliage as in orchard pruning. Probably the tool most useful is the pole pruning saw which enables a worker to cut above his head or to reach into a dense crown such as that of cedar and juniper. Also, if workers are not practiced in good axmanship, the saw is a safer tool and not so tiring after the breaking-in period.

Now that the methods of securing brush have been explained, we turn our attention to where and how to use it, and this of course depends on the amount and type of erosion present. Brush should be used only in the smaller gullies at the heads of small drainages or in abandoned roads where the amount of run-off will not be too great. On farm and grazing land, erosion can be attacked where it starts, and that is the place to begin. At the heads of incipient rills and gullies, a light layer or mat of brush will start grass in the depressions, and extending such a layer on down stream or down the slope helps to keep the force and volume of water down to a degree where vegetation can survive and can compete successfully against erosion.

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Sooner or later the waterflow will increase to where a layer of brush alone will not withstand flood, and then it must be weighted with rock, or check damming must be resorted to.

Whether or not a continuous lining or layer of brush is better than intermittent or alternate lengths of brush and bare channel is a question still open to experiment. Since the role of the brush is to stimulate vegetative growth as well as to check and retard the waterflow, it seems that the continuous cover, no heavier than necessary, is to be preferred, with checks, or an increased amount, at intervals to help in lessening the velocity. This should permit establishment of a continuous grass cover the length of the waterflow. Today some of the waterflows that were treated with intermittent brush checks and mats show the spaces between still as bare as they were 3 or 4 years ago when the work was done, and the brush is still so

thick in the checks that there is no growth whatever. This is open to question, however, as the increased cost and amount of brush available must be considered. The same idea in treatment applies to contour brush percolators on the range which often are built as high windrows that actually kill out vegetation for some period or which may be kicked out by cattle. Were even and thinner applications of brush used, two or three times the area of ground could be covered by the same amount, and in the end more grass would become well established.

The proper use of brush is all a very simple matter and, as someone wisely said, it is something every farmer can do. The only cash outlay is the price of a good pruning saw. Best of all, from the standpoint of our increasingly important farm forestry program, it is a type of work which gives employment in the slack season.

TIMBER AND CUT-OVER LAND PROBLEMS IN THE PACIFIC NORTHWEST

BY J. H. CHRIST ¹

BETTER land use through farmer marketing organization is unique as a major goal of the Forest Products Cooperative Association of the State of Washington. This new Pacific Northwest "farm co-op" is pioneering in an unusual but promising direction in a seemingly already crowded group-marketing field. Snohomish County, Wash., is noted for its partiality to this form of putting its products on the market. Ninety percent of its dairy products, for example, move from the farm through co-ops, as do 80 to 85 percent of its poultry and 60 to 65 percent of its berries and tree fruits. The forest products association, however, is the first to be set up west of the Mississippi River for handling this particular "crop." Although a handful of timber product cooperatives exist on the eastern side of the continent, the Washington State association is believed to be the first anywhere to base its membership on sustained-yield harvesting of the timber it markets and to call upon the Soil Conservation Service to give its members technical guidance in management of their woodlands and harvesting of their timber crops. The novel venture already is attracting wide and favorable attention the length of the Pacific Coast, among both loggers and mill men. They believe that cooperative marketing of timber products grown and harvested according to conservation rules is practicable.

For a number of years, small farmers in Snohomish and other western Washington and Oregon counties have felt themselves to be handicapped in getting top prices on a market stiffened by big timber company competition, unless they cut their timber land clear for quick sale in quantity. Such cutting means lower per-acre profits, exhaustion of their timber and conversion of their farms into just so much more cut-over land. Even though the average farmer in this county, for example, has not more than 100 acres of timber—largely good second-growth fir and hemlock, black cottonwood, and some cedar, maple and alder in the untilled bottoms—and cannot go in for large-scale logging methods profitably, farm timber comprises a substantial portion of the remaining timber in the coastal area.

Thus the 1935 agricultural census showed that woodlands on Washington farms occupy a larger area than does wheat, with approximately one-fourth of the privately owned forest land and a tenth of the total forest area classified as farm woodland, including woodland pastures. It disclosed that a third of the State's farm families benefit from the sale of forest products, and that 9.2 percent of all Washington farms reporting in 1934 sold an average of \$86 worth of such products.

The question was how to realize on this farm timber land profitably and safely. This was the problem the Soil Conservation Service foresters ran into at the

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outset when the Snohomish C. C. C. Camp was established in 1938. The conservation practices that were demonstrated in cooperation with operators in the camp area followed the general pattern of streambank control in the narrow valleys to stop costly erosion in high-priced bottomlands, and of sustained-yield cutting, timber stand improvement, planting and other woodland management practices on the hill land to protect the watersheds.

The last-mentioned work in particular caught the eye of farmers such as M. C. James of Granite Falls, a former Ohio county extension agent, who already was talking cooperative marketing of his own and his neighbors' pulpwood, cedar poles, and other forest products. Regional Forester C. Svendby and Camp Forester William A. Tinney also thought there should be some way of turning the idea and the practices into a workable concrete plan, but knew that it could not be accomplished overnight. A visit to the Snohomish area in 1939 by John F. Preston, chief of the woodland management division of the Soil Conservation Service, and discussions at that time with Mr. James and the Region-9 Service foresters, helped in giving the idea a more tangible form.

Less than a year later, Mr. James and forty-four other Snohomish County farmers organized the forest products association, as a nonprofit, noncapital stock corporation aimed at "cooperative marketing, for eliminating speculation and waste and for stabilizing forest products markets, and the maintenance of the maximum production capacity of the forest land." It now has its charter from the Washington Secretary of State and is losing no time in getting down to business under direction of its seven-man board of directors of which Mr. James is president. Manager Lester Sims, of Sultan, was appointed even before organization was completed, and County Agent A. Z. Smith is an unofficial but definitely active adviser in organizing detail.

Some of the charter members are experienced loggers and relatively large-scale operators, and others are dairy or general diversified farmers with small timber acreages. All are agreed on two points: That they can market better products at higher prices with the help of the co-op, and that they can depend upon their timber to provide dependable income for many years to come if they handle their woodland properly.

Every association member agrees to observe sustained-yield cutting methods, both on the 5 acres or more of timber owned at the time of joining the co-op and on any acquired later. The latter stipulation voted by the board before the association undertook its campaign for an extensive membership, is looked

upon by forestry authorities as a most significant forward step in the recognition of sound forestry land use in a region still blessed with large and valuable timber stands. The potential possibilities also are reflected in the fact that the association, at first organized at Everett as a Snohomish County set-up, soon was broadened to its present status, with a view toward making it possible for farmers in other western Washington counties with similar problems to organize their own farm forestry cooperatives.

The Soil Conservation Service, for its part, is committed to cooperate to the extent of its available personnel and other facilities with the association members on lands on which they as Service cooperators practice sustained-yield harvesting of their forest products. Figures on the potential volume of forest products business, by the 50 or so charter members alone, give an idea of the task. The best available estimates place the total Snohomish County farm woodland at between 75,000 and 80,000 acres, some of the second-growth timber running up to 30 inches in diameter. The organizers control around 5,000 growing acres, about 4,000 acres of which is workable and the other thousand expected to be within 15 or 20 years. Preliminary surveys by Service foresters indicate that they should be able to market in the neighborhood of 4,000 cords of fir, hemlock, and cottonwood pulpwood a year. Douglas fir pulpwood has a market here. On the basis of the organizing membership, other products include up to a thousand cedar poles a year depending on the number of farmers cutting them and on the market condition, fence posts some hardwood of alder and maple, fuel products, tie timber in the log and hewed, shingle bolts, and cascara bark and fern. The gross marketing on this basis is figured at between \$30,000 and \$35,000 a year. Increased co-op membership will bring the totals up proportionately.

The Service plans to extend technical aid to the co-op growers by giving information on soils best suited to timber production, by guiding the farmers in meeting timber product specifications, predicting their yields, making physical inventories of the woods, giving advice on cutting methods in line with the sustained-yield objectives of the association and on new plantings by members, giving help in deciding on the proper products to be made from the timber for the greatest return to the grower, and by giving advice when asked on actual logging management practices.

The association expects to benefit its members in various ways. Foremost, of course, is the expectation of receiving better prices through pooled quantity



Typical streambank control. Live brush-mat riprapping as placed with the aid of the Snohomish, Wash., C. C. C. camp along streams that have been cutting valuable bottomlands and endangering the economic units of which timber on bordering uplands is a part.

marketing of timber products for which the co-op board may set up grade rules and which the grower agrees to deliver as directed in good marketable condition. He may sell for direct consumption by neighbors, or he may have certain products specifically exempted from his blanket marketing agreement. The "habit" of sustained yield and related sound forestry practice will be of continuing benefit to the members, for whom the association may make rules on the manner of harvesting and handling as well as on amounts to be sold.

A long list of forest products, aside from the regular timber "staples," already has been compiled by Manager Sims, and an effort will be made to assist members in finding markets for them, from peeled logs to Christmas trees. The association may be able, also, to make tractor power available to growers not in a position to provide themselves independently with such facilities for getting out what Mr. James termed their "little dabs" of timber products.

Better fire protection through group action has been studied, as have the problems of more effective utilization of information from the State Forestry department, passing along to members any advantages in work, and other benefits to be derived from such organization. One important subject now being considered is the possibility of using the association's influence to secure stricter State laws against theft of cascara bark and other timber products in the woods.

Finally, the buyers are able to reap their own benefits from the new organization, through more orderly and dependable marketing of small farm products, marketing of only those timber products that measure up to their standards and grade requirements, and so

on. At the outset, the association interviewed every buyer but one between Bellingham and Tacoma to sound out the reaction to the new co-op marketing idea. The plan was received with unanimous favor by pulp mill, furniture factory, veneer plant and every other timber products user. Buyers liked the prospect of being able to reduce their bookkeeping and other costs by not having to handle the little amounts separately. The association has stated clearly that it has no intention of holding up prices, but expects only to undertake to sell its members' products at the "best prices obtainable under existing marketing conditions."

The forestry co-op organizers are neither theorists nor immature experimenters. The directors include men in their eighties, whose fingers are curved to ax and saw handles and calloused to splinters. I recall one board meeting not long ago when these men worked from 8 p. m. until well after midnight, drove home—some of them more than 20 miles—and nearly every one was found on the job in his timber the next morning. Each member pays his \$2.50 membership fee; thus the association will be financed with a reserve fund built up from not to exceed 5 percent of the net returns in any fiscal year, drawing 3-percent interest for the grower. Cost of handling is deducted, of course, at the time of marketing.

The six regularly elected directors are all farmers who know the measure of a tree. Richard Roesiger of Lake Roesiger is vice-president, and other directors are R. G. Brooks of Hartford, John Spada of Snohomish, who is also master of the Snohomish County Pomona Grange, H. S. Ofstie of Monroe, and W. R. Millard

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SELF-GOVERNING PRINCIPLES OF SOIL CONSERVATION DISTRICTS

BY MELVILLE H. COHEE ¹

THE expression "soil conservation district philosophy" is often heard or used when Soil Conservation Service and other Federal and State agency personnel are discussing the rapidly advancing work of these districts throughout the country. It is unusual for anyone to challenge the premise that there is a districts philosophy; but on the other hand it is not always apparent that those who use the expression fully appreciate its significance, or that they conduct their day-by-day work in relation to soil conservation districts in such a way as to demonstrate their understanding of it.

It is questionable whether or not a satisfactory definition can be formulated for "districts philosophy" in the sense of clear and concise dictionary terms. Yet there are certain basic principles underlying the district, and beginning with provisions of a State soil conservation district law, which, if correctly appreciated and followed, will provide in the composite a true districts philosophy. The word "philosophy" may be considered, for purposes of this article, to mean a body of principles underlying this particular major discipline or organizational activity, namely, soil conservation districts. Those principles, comprising the soil conservation district philosophy, must be fully appreciated by all concerned if the districts movement is to be carried forward in the most satisfactory and expeditious manner.

Obviously, the most logical and ethical key to correct thinking with respect to any particular district is the State law under which that district was organized. Furthermore, from a study of any one of the 38 State soil conservation districts laws, it is easy to appreciate the general democratic procedure and self-governing principles involved in the creation, organization, and operation of a soil conservation district. The democratic process is the heart of the whole district philosophy.

The basic principles pertinent to the soil conservation district philosophy are threefold. First, it is clear that soil conservation districts are local units of government organized under State laws and answerable to the State legislatures. They operate in most instances over naturally bounded areas and come into existence only in response to the petition and favorable referendum vote of the land owners and operators carrying on agricultural operations within their boundaries. In this way, the necessary basis has been laid for the maximum exercise of initiative and responsibility by the farmers themselves.

Second, through the diligent efforts of most of the 38 State legislatures, the districts are equipped with a broad range of governmental powers—powers which are necessary if the districts are to perform their functions with efficiency. It may be said in general that the districts are authorized to do everything that needs to be done to achieve "the prevention and control of soil erosion and the conservation of soil and

soil resources."² More particularly, the districts are authorized to carry out erosion control and soil conservation measures of all types—engineering operations, changes in methods of cultivation, the growing of vegetation, and changes in land use—on all lands within the district, whether public or privately owned. They may give assistance to farmers in preparing intensive conservation plans for their lands and in putting those plans into effect, through technical guidance and supervision, the loan of field equipment and the loan or gift of seeds and seedlings and of construction and other types of materials. They may act as land-management agencies by acquiring lands through purchase or lease and by administering those lands in any way that will advance their objectives. They may administer erosion control and soil conservation projects and activities, whether undertaken by themselves or by Federal or State agencies and entrusted to their care. They may, by referendum,

¹ Chief, program procedures division, Soil Conservation Service, Washington, D. C.

² With no exception, all soil conservation districts laws either include the exact words quoted or words meaning the same.

adopt land use regulations in the public interest and enforce such regulations uniformly on all lands within their boundaries.³ While the districts are limited to working in the field of "erosion control and soil conservation," that field is a very broad one in agriculture; and, generally speaking, soil conservation can be achieved effectively only if all lands are put to their proper use. Any essential undertakings to that end are plainly within the legal province of the districts.

Third, and a fact that is an obvious conclusion from the foregoing, it should be understood that soil conservation districts are "action" agencies and not merely "planning" agencies. To be sure, any action agency, in the interest of carrying on its work effectively, must make plans; to that end all soil conservation districts now in operation have first formulated some type of district-wide plan. It is equally clear, however, that the work of districts does not stop with the formulation of a plan; it includes also the direct effectuation of that plan through action on the land.

The conditions placed on assistance to districts are important to operation of the underlying principles. For many good reasons, the soil conservation districts laws have not empowered the districts with the taxing powers. Thus, for resources with which to operate their programs the districts are dependent for the most part upon State appropriations, which to date usually have been small or none at all, and assistance from Federal and local agencies. However, domination of soil conservation districts by cooperating agencies must be guarded against if the district movement is to develop along the most healthy and satisfactory lines.

Since it is not to be expected that assistance from public or private agencies to a soil conservation district will be in the form of outright, unconditional grants, the arrangements surrounding such assistance are of utmost importance to the future of the district movement. Owners and operators of land lying within the boundaries of a soil conservation district to an appreciable degree understand in their own way the real district philosophy. They cherish the democratic-procedure principle. They will defend their rights to civil liberties. They want to be self-governed. They appreciate the desirability of a local unit of government established for the specific purpose of controlling erosion and conserving the soil resources. But, generally speaking, they also need and want help toward putting a farm or ranch conservation plan into operation on their respective farms and ranches. It is entirely possible and probable, therefore, that the governing bodies of soil conservation districts, as well as

owners and operators of lands therein, are vulnerable to all kinds of arrangements and procedures which are not in keeping with the democratic essence of the true district philosophy. This is possible since these men are frequently inclined to overlook some of the basic principles essential to the long-time development and success of the district because of their immediate desire to obtain material assistance.

It therefore is not unreasonable to charge every public agency and every private citizen assisting soil conservation districts with the responsibility of protecting and assisting in the proper development of the district movement. When such agencies and individuals thoroughly understand the underlying principles of the district approach in soil conservation and erosion control, they should have little difficulty in discharging this responsibility. But if districts are treated without regard to their potential position in the field of land-use adjustment, that is, as autonomous agencies—even though at the outset the inexperienced district officials may lack initiative, administrative ability, and the background necessary to exercise their responsibilities in the best way—the fault for the failure of districts to stand on their own feet and solve their own problems will rest squarely on the local, State and Federal cooperating agencies.

Many public agencies may assist the districts. The Soil Conservation Service is not the only agency that can and should play an important part in furthering the correct appreciation of the soil conservation district philosophy, even though to date it has been very active in assisting districts. Several agencies can be named, including the State extension services, Federal Forest Service, State departments of vocational education, Bureau of Agricultural Economics, State conservation commissions or State forestry departments, Farm Security Administration, State agricultural experiment stations, Agricultural Adjustment Administration, local county boards or commissioners, Farm Credit Administration, and others. Certain desirable propositions may be considered by the Soil Conservation Service in assisting soil conservation districts, if it is to make its greatest contribution to their proper development. These desirable propositions are discussed in the following numbered paragraphs:

1. The entire personnel of an assisting agency must thoroughly understand the underlying principles of the soil conservation district. It should be appreciated that Soil Conservation Service personnel, and personnel of many other agencies assisting the districts either at the present or in the future, were accustomed, before the advent of the districts, to carrying out

³ Six States—Vermont, Minnesota, Iowa, Idaho, New York, and Nebraska—have not granted to farmers the authority for enacting or enforcing land-use ordinances.

programs directly rather than by giving assistance to another agency. Thus, to some extent, it is to be expected that personnel, in many instances, finding the circumstances changed, will consider themselves as among those who appreciate the districts philosophy and yet unwittingly will conduct themselves in such a way as to ignore almost totally the cardinal principles necessary for the success of the district movement.

2. Those directly interested in soil conservation districts must realize the need for widespread appreciation of the correct district philosophy, and they must also develop ways and means of bringing about this appreciation. This responsibility rests heavily on those agencies making substantial assistance available to districts, and upon the governing bodies of the districts. In any new development similar to the soil conservation district movement, it is essential that there be "sponsoring" agencies or individuals to carry along the movement until such time as it is old enough to proceed on the basis of its own experiences and momentum. In this instance, the governing bodies of soil conservation districts will soon gain experience and an appreciation of their responsibilities sufficient to make unnecessary any "guardianship" type of aid. Nevertheless, two State agencies—the extension service and the State soil conservation committee—and one Federal agency, the Soil Conservation Service, should feel an especially heavy responsibility in this regard.

3. All branches of assisting agencies must realize that the organization of soil conservation districts is the responsibility of local farmers and ranchmen and respective State soil conservation committees, and not of any Federal agency. This, however, should not prevent representatives of Federal agencies or any other interested agency from advising and consulting with either farmers and ranchmen or the State soil conservation committee, regarding organization of districts.

4. Assisting agencies must recognize that district governing bodies are responsible for development of the districts and, therefore, outside assistance to such districts should be made available in such a manner as to provide fully for an appreciation of the responsibility of the district and its governing body. In view of the fact that soil conservation districts are new, and that sufficient time in all cases has not elapsed for district governing bodies to become thoroughly conversant with their responsibilities and the best methods for exercising them, it is particularly urgent that representatives of assisting agencies be alert to the fact that by acting too freely for the district they may jeopardize the proper development of initiative on the part of the members of the governing body.

5. All procedures formulated and followed by any agency in making its assistance available to soil conservation districts should be in keeping with the underlying principles; procedures should not be such as to make it impossible for representatives of the assisting agencies to recognize the proper prerogatives of the districts they may be helping. If the Chiefs and assistant heads of the various Federal and State agencies will continue to make special efforts in this direction, any confusion on the part of their subordinates concerning the proper role of an assisting agency in relation to a soil conservation district will be more readily eliminated.

Some Department of Agriculture interests are similar to those of soil conservation districts. As this is written, the Department of Agriculture is assisting 263 soil conservation districts, and memoranda of understanding between the Department and these districts, distributed over 30 States, are in effect. Departmental interest does not rest alone in the fact that these districts need technical guidance, equipment, materials, labor, and other assistance, which the Department is directed by the Congress to supply. It lies also in the fact that the objectives of good land use are common for both the districts and the Department. It is, among other reasons, because of this community of purpose that some departmental workers mistakenly contend that any program carried out by a district, in which a departmental agency is cooperating, should be a joint responsibility of the district and the departmental agency or agencies concerned. Work undertaken by a soil conservation district in its own right is truly the responsibility of that district, regardless of the type or amount of assistance that it may receive from any agency or individual.

A soil conservation district, as any other well-organized and efficiently operating unit of local government, needs plans for use in giving direction to its work. Moreover, agencies of the State or of the Federal government can best decide whether or not to assist a soil conservation district if they first know the proposed course of action which the district chooses to follow in reaching its objectives. Thus, as might be expected, in each memorandum of understanding thus far negotiated between a soil conservation district and the Department of Agriculture, it is provided that the district will prepare a program and a work plan.

The district philosophy manifests itself in practical programs, plans, and operations. A soil conservation district program is the district governing body's statement of erosion conditions, soil conservation problems and their causes, and the major accomplish-

ments which the district hopes to attain in the solution of such problems. The program is essentially an educational and informational document describing agricultural conditions, problems, and objectives. Once formulated, it is a source of most of the facts and information used by the district in carrying on its educational and informational work. In many instances, the district program has been widely circulated in order to acquaint farmers and others interested in agricultural problems with a background of the facts establishing the reasons for, and the objectives of the district. In short, the soil conservation district program provides the answer as to why soil conservation and erosion control activities are essential and gives a general picture of the accomplishments which the district hopes to realize.

The soil conservation district work plan, on the other hand, is a presentation of the specific conservation practices and methods proposed for application on lands within the district, the current plan of district activities and procedures for carrying on such activities, and the possible sources of assistance that may be utilized by the district. It is commonly said that the district work plan provides a statement regarding what is to be done, and where, when, how, and by whom. To be effective the district work plan must be dynamic rather than static—revised continually and progressively for improvement on the basis of additional information, experience, and newly developed objectives.

As might be expected, a review of many of the soil conservation district programs and work plans that have been prepared to date reveals that they were compiled in various and sundry ways and contain a wide variety of context and scope of statements. Some contain statements explaining exactly how they were prepared. Even without such statements, it is obvious that many were prepared entirely by assisting agencies and that the governing bodies offered their main contribution through their signatures. From a review of other programs and work plans it is easy to conclude, without question, that the members of the governing body, with the assistance of land owners and operators and representatives of local, State, and Federal agencies, have really carried out the job themselves. Obviously, the latter course is more desirable if the soil conservation district philosophy is to become a reality in operation.

When public agencies are called upon to assist the district in this work, their representatives can do much to show their real understanding of the purpose and principles surrounding the district if, in each step of

the preparation of the two district documents, they encourage the district governing body to assume its responsibilities in fact and not by approbation alone. In this respect, it is noteworthy that recently more and more district governing bodies not only have been assuming this important responsibility but have actually eliminated superfluous suggestions heretofore included in some programs and work plans. The assumption of this responsibility is not primarily a result of experience on the part of the governing bodies, for obviously the governing body of a soil conservation district organized this month has less experience than that of a district created two years ago. The gratifying fact is that representatives of assisting agencies—the State soil conservation committees, the State extension services, the Federal Soil Conservation Service and others—are more and more appreciating the fact that it is possible to help a soil conservation district governing body without doing all the work.

Appropriateness of operation on the part of assisting agencies, with respect to districts and appreciation of the district philosophy, is by no means limited to preparation of the district program and work plan. In fact, that is a more or less minor part compared to the entire cooperation between an agency and a district over a period of years. Another consideration of far-reaching consequence is that pertaining to the conditions established by an assisting agency surrounding its help made available to a district for the purpose of carrying on district work. To illustrate this point, the form for cooperative agreement used between the district and the land owners and operators and covering farm conservation plans may be cited.

The Soil Conservation Service, through the memorandum of understanding establishing relations between it and a district, is given the prerogative to find satisfactory or unsatisfactory the form for cooperative agreement adopted by the district to cover farm or ranch conservation plans in cases where the district through personnel of the Service assigned to it provides assistance in their preparation and execution. The point here is not whether there should be a cooperative agreement, or if it should include consideration of all parts of a farm or ranch; and neither is it whether or not the Service should be given such a responsibility as a condition to extending assistance to a district. Rather, it is how the Service should perform with respect to this particular "condition" on its assistance to the district. As a matter of fact, in order to expedite district work at the outset some three years ago, the Service released to its field staffs a "suggested" form for cooperative agreement to be presented for consideration by the governing bodies of

districts. Obviously, the Service had certain basic provisions in mind for such a cooperative agreement form; otherwise, it could not have prepared a suggested form.

Perhaps, instead of a detailed form, the Service should have released to its field staffs merely a statement of the general fundamentals to be covered by provisions of a cooperative agreement. The district supervisors could then draft, in their own language, a form for a farmer-district cooperative agreement with the appreciation that it was their form, and that since it incorporated the basic principles required by the assisting agency (in this case, the Soil Conservation Service) it would likewise be satisfactory to that agency. Such a procedure would be in complete harmony with the district philosophy, and the principle underlying this suggested approach is one that might well be observed in other phases of cooperation between any agency and a soil conservation district.

At present, the primary attack of soil conservation districts toward their solution of erosion control and soil conservation problems is, first, by distribution of general and practical information to land owners and operators of lands lying within the district as to practices and methods of farming that will control erosion and facilitate soil conservation; and, second, by assisting farmers or ranchers in forming and applying individual farm and ranch conservation plans and work on district-owned or leased lands that will bring about the desired land use and soil conservation practices. For the most part this work actually is carried on by personnel from assisting agencies under the direction of the governing bodies of the districts and in keeping with district made plans. Upon request, and as available resources permit, Soil Conservation Service personnel are assigned to districts for the purpose of assisting in the preparation of individual farm conservation plans and in other ways that help to further the purposes of the district—S. C. S.-C. C. C. camp labor, with facilitating personnel, materials and equipment, affords a source of real assistance to districts.

The farm conservation plans formulated by the land-owners and operators with aid of personnel available to the district, as referred to above, are covered by cooperative agreements. In view of the manner of approach which most soil conservation districts are following today in carrying out their work, it is readily apparent that personnel from the Service, and all other agencies cooperating with a district, are in strategic positions with reference to their conduct regarding the fundamental principles underlying a conservation district and the success or failure of a district as such.

Quite properly, the Service does not guarantee that the farm conservation plan which its personnel assists in formulating will completely control erosion on a farm. The determination of the degree to which the plan will be effective in erosion control—as an indication of the desirability of the supervisors signing an agreement with the farmer covering the plan—is a proper responsibility of the governing body of the district and of the land owners and operators involved. Service personnel have the responsibility of presenting all facts and all alternatives in the situation to the governing body and allowing it to decide from knowledge of local conditions and circumstances whether or not such a plan accomplishes a sufficient objective to be a worth-while endeavor. By and large, experience seems to indicate that if a plan of conservation operations is acceptable to the district governing body—where it has a complete knowledge of facts in the case—such a plan would also provide for practical soil conservation undertakings and thereby would be acceptable to the Service. The Service should not establish arbitrary standards for farm conservation plans which are acceptable to it but which may not represent the desires of the district or the farmers. The Service has the responsibility of so informing the district governing body that it may have a complete understanding of the elements of good farm conservation plans and that it may make decisions as to acceptability on an equitable basis. The farm planner—assigned to a district by an assisting agency—who has a problem of recommending what to do with the so-called “submarginal” or “uneconomic” unit should be guided in a major degree by the judgments of well-informed members of the governing body of the district after they have all the facts pertaining to the case.

This approach can be used just as effectively as an alternative method used prior to the advent of soil conservation districts whereby the Service personnel and the land owners and operators involved assumed full responsibility for the correctness and completeness of farm conservation plans. At the same time, such conjecture as to the right way to work with a district does not mean that the Service is obligated to continue assisting a district even where the governing body either lacks information concerning farm conservation plans or for some reason does not establish standards high enough to warrant expenditures of public resources. It is not counter to the district philosophy, as I conceive it, that any agency assisting a district should establish standards governing its assistance whereby the resources at the command of

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NEW CONSERVATION PRACTICES REPLACE THE OLD IN THE PEACH ORCHARD

BY JOHN T. BREGGER¹

INTENSIVE cultivation has been for many years the traditional culture for peach growing. On the long, sloping sites normally chosen in order to secure good air drainage, the natural result of such a practice is erosion—usually extensive erosion. If ever there was an agricultural industry with practices favoring erosion and land abandonment, it is to be found in many peach districts of the United States. The situation is a serious one and it should be faced before conditions become more acute.

A clear understanding as to why and how intensive cultivation in peach orchards is so harmful should help greatly in solving the erosion problem. In general there are three reasons, the first of which is that most peach orchards in the country were square planted without any attempt to run the straight rows across the slope even where it was possible. This means invariably that the cultivation, in either direction, must be more or less up and down hill. Furthermore, the cultivation season is long and continuous; usually cultivation is practiced without let-up from blossom-time until harvest, all through the season of high-intensity rains in the humid sections of our country. To make matters even worse, peach orchards invariably are clean cultivated—whether or not there are weeds or other vegetation to be destroyed—and the result is that at times more soil moisture is released by evaporation than is conserved by the creation of a dust mulch. Whether intentional or otherwise the objective of a great deal of peach orchard cultivation has been to destroy completely or to cover up every last bit of living or dead vegetation on the soil.

Naturally not all peach growers are playing the part of the "horrible example." Some of them, like the corn growers of the Middle West and elsewhere, already have learned that excessive cultivation long since reached the point of diminishing returns; that it rarely pays beyond the point of correcting the actual competition of weeds and other vegetation for a supply of moisture or soil nutrients not present in sufficient quantity for both at any given time. The turning back from overcultivation which was made so easy by our modern farm machinery, has not been too general among peach growers chiefly because of the significant lack of factual data on which successful curtailment of



A knee-high stand of Austrian winter peas used as a cover crop in a South Carolina peach orchard.

cultivation can be based. In the attempt of the few to find the answer to this question, the problem is being solved to some extent without the aid of the experiment stations, and it is hoped that a survey and evaluation of these "trial and error" grower experiences may be of use to those who need this information.

The peach tree is more sensitive to privations brought on by competition with other plants than the apple and some other tree fruits, and for this reason cultivation has seemed necessary for optimum growth of both peach trees and fruit. Closer examination reveals, however, that there are certain critical times when a peach tree needs ample supplies of moisture and nitrogen both of which may be appropriated by competing vegetation. One of the most critical times is in early spring when the trees are not only blooming or setting fruit, but making new wood growth with an abundance of foliage. At this time of year, moisture is usually present in abundance while soluble nutrients in the soil are much more limited. This stage of fast growth, accompanied by rapid fruit enlargement, is followed by a period wherein there is less growth and almost no fruit enlargement. Then, during the month or so preceding harvest, the final fruit swell takes place, and during this period the tree demands an abundance of soil moisture but much less of the nitrates and other nutrients.

Orchard cultivation methods as used by growers in an attempt to meet these conditions frequently have "overshot the mark." In the first place, cultivation has served the necessary purpose of providing soil aeration in early spring to a greater extent than it has provided for the purpose of moisture conservation. The demand for sufficient soil nitrogen usually can be supplied more economically through fertilization than

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by operations to speed up the breaking down of the soil humus and the orchard cover crop. Again, during the pit-hardening period when moisture demands are not ordinarily great, clean cultivation usually is not necessary. Throughout the more critical final growth period of the peach, however, there can be serious competition for moisture from tall-growing and deep-rooted vegetation, but here again clean cultivation may not be necessary. Mowing has been successfully substituted for any kind of cultivation under such conditions; or, a type of cultivation may be employed which significantly reduces the transpiration rate of the cover crop without exposing the soil to possible erosion.

The distinction between deep- and shallow-rooted cover crops should be considered, especially when mowing, or some method of curtailing top growth is to be omitted during critical periods of low rainfall or moisture shortage. With a shallow-rooted cover crop on a "deep" soil where peach trees are deep-rooted, the effect of the cover crop can be ignored as far as the trees are concerned. Under such conditions, the trees have access to the only existing moisture reserve, and the cover crop either dies or wilts and becomes practically dormant. An important distinction must be made at this point in that young peach trees do not have a sufficient number of roots at these lower depths and therefore cannot survive the competition of other vegetation during the growing season. Even with young trees, however, cultivation can be confined to a strip or circle adjacent to the trees so that plenty of vegetation is left in the row middles for the complete, or at least adequate, control of erosion.

The type of cultivation probably has more to do with its harmful and beneficial effects than any other single factor. I have already referred several times to "clean" cultivation as a very common cause of promoting serious erosion; until recent years no other kind was given much thought unless one considers the opposite of clean cultivation often described as the "poor" or "careless" job. Today we intentionally practice "trashy" or "duckfoot" cultivation; this means not so much a partial job of cultivation as a method designed to leave cover crop residues, in whole or in part, on the soil surface instead of turning them completely under so that they will decay immediately. Farm machinery ranging from the single shovel "sweep" to the wider weed eradicator, and even the ordinary disk harrow, may be used to bring about the desired condition.

Next to clean cultivation, the most variable, if not ineffective, practice which has become associated with

commercial peach growing is use of the so-called winter cover crop. Ordinarily planted too late and at the driest period of the year, it rarely makes sufficient growth to control fall and winter erosion. In other words, it is not a "winter cover crop" at all, but a spring cover crop. What is sometimes even more surprising is the fact that peach growers often will destroy a good protective cover of volunteer crabgrass and other weeds—or perhaps a summer cover crop—only to replace it with a poor cover of the planted crop. From the standpoint of both soil conservation and economy this is unfortunate for the peach growers, particularly when they plant an expensive crop such as winter vetch. Even rye and ryegrass must be planted early in the fall to allow stooling out and to make a satisfactory ground cover.

Already peach growers themselves have pointed the way in the direction of conservation practices that will control erosion and at the same time allow optimum fruit production. This is especially true when the question of orchard longevity, an important factor in total yields and income, is considered. The trends as outlined in the following paragraphs (1, 2, and 3) are indicative of the progress being made by growers toward the practical conservation methods possible even in square planted orchards:

1. *Permanent vegetation.*—The complete elimination of cultivation may seem an impossible and impractical way of controlling erosion in the peach orchard without curtailment of quantity or quality of production. Yet various peach growers in Pennsylvania, Michigan, Arkansas, Kentucky, and Tennessee have done this very thing. A typical example is the orchard of Herman Yopp near Paducah, Ky., which has been in annual lespedeza sod for about 8 years. Not only has the former state of erosion been eliminated but tree growth and production have been maintained at a high level. Another example of this same practice is to be found in the orchards of the Arkansas Orchards Co. near Nashville, Ark., where peach trees actually regained their lost vigor under a 7-year treatment of lespedeza cover with a slight increase in the nitrogen application. A peach orchard at the Tennessee Experiment Station has received no cultivation for approximately 10 years, and here it was found by actual experimentation that additional nitrogen is necessary under these conditions. This was important, as formerly it had been taken for granted that a moisture shortage rather than a nitrogen shortage was the chief limiting factor under a continuous cover. Recent studies by the author in South Carolina indicate that although moisture may be depleted to a certain extent

in the topsoil, bearing peach trees having access to subsoil moisture below the 2-foot level do not suffer from moisture shortage because of the presence of a shallow-rooted cover crop such as Kobe lespedeza. When deeper-rooted cover crops are used, frequent mowing may be advisable.

2. *Strip vegetation*.—Next to a complete cover, we may have a continuous vegetative cover which is broken into strips instead of being solid. This is in more or less common usage, but still in a vast minority as far as general commercial practice is concerned. A

good example of a peach orchard under partial grass sod is to be found at Clemson College, S. C. Bermuda grass has been allowed to occupy about one-half the total ground area, being located in the contour tree rows while the middles receive two or three cultivations per year. Crabgrass is allowed to grow following the cultivation period, and usually a winter cover crop of rye is planted in the fall. In spite of the Bermuda grass sod, however, this orchard has borne large crops of high quality fruit along with a vigorous tree growth.

Another type of strip cultivation is exemplified by the experience of Ed Miller, near Romney, W. Va., who has practiced alternate row cultivation in a bearing peach orchard for many years and in his opinion has maintained as good yields and fruit size as on adjacent blocks where all middles are cultivated. Erosion has been controlled remarkably well on a rather steep slope by these alternate strips of continuous sod; erosion control is of course the main justification for the practice in square planted orchards. Under contour planting it would be even more effective and could be utilized for the increase of soil organic matter by alternating the vegetation and cultivation every few years and combining with a winter cover crop in the cultivated middles.

3. *The winter cover crop*.—It has been stated that the main limitation of a winter cover crop has been its lateness or slowness of growth in the fall. To overcome this situation, Purcell McCue, a leading peach grower of Albermarle County, Va., plants his rye cover immediately following peach harvest, the last week of August or early in September. By the time cold weather curtails its growth his rye is well stooled out and covers the ground like a carpet. Ryegrass also will make a compact cover when planted in early fall and will give good winter protection. On the other



Trashy cultivation of rye cover crop (right), in contrast to usual cultivation of vetch cover crop (left).

hand, soil protection may be secured without a heavy growth of winter cover crop if volunteer crabgrass and weed growth is left on the soil surface as mulch. P. S. Wade, commercial peach grower of Cornelia, Ga., plants his winter cover crop of rye and winter peas by a trashy cultivation that provides adequate protection even though the planted cover crop does not make its growth until spring. An additional advantage of this trashy cultivation, as practiced by Mr. Wade, shows up in the high level of organic matter found in the soil of his 28-year-old peach orchard. It has been found that crimson clover may be sown without cultivation by taking advantage of the firm seedbed and crabgrass residue already there to provide for better germination and growth, especially in the fall when dry weather is most likely to occur in many peach districts.

A new type of cover cropping appears to show promise under peach orchard conditions. This practice is practically new as far as its adaptation to commercial plantings is concerned, but is theoretically sound. If, instead of relying on a fall-planted winter cover crop for soil protection and organic matter additions, a summer-planted crop of a suitable legume-nonlegume mixture is planted during the summer, a good soil cover can be obtained. Soybeans or cowpeas mixed with Sudan grass makes an especially good combination which can be mowed during dry weather or just before peach harvest. Even though these plants are killed by winter freezing, the ground cover—essentially an anchored mulch—is a good protection against run-off and erosion, and a significant amount of valuable organic material is added to the topsoil in the spring.

Although the foregoing discussion has been confined to vegetative types of conservation orchard practices,

(Continued on p. 164)

SELF-GOVERNING PRINCIPLES OF SOIL CONSERVATION DISTRICTS

(Continued from p. 160)

that agency are to be expended in an efficient way.

There are countless additional phases of soil conservation district organization, and analyses of assistance from agencies to a district, which could be reviewed to point toward establishment of the premise that there is a district philosophy and that it can be furthered or constricted by those assisting agencies.

Further dissertation on details seems unnecessary and would not alter the conclusion that an appreciation of the district philosophy should guide all interested persons toward the objective of satisfactory operation of districts. To be sure, sometimes what appears at the moment to be a violation of such a philosophy may in reality be a necessary expedient to further its real end; but it is the gross violations and permanent trends away from the principles germane to the real "districts way of operation" that must be avoided at all cost. Oftentimes the personnel of assisting agencies become impatient with the new approach through districts, would much prefer to discontinue relations with them, and would rather work directly with land owners and operators even though the total amount of conservation on the land would not be as great if the latter course were followed. This feeling of impatience is truly commendable provided such personnel lend their efforts toward encouraging and assisting the governing body of the district

to equip itself to carry on its work; but it is a dangerous tendency when the personnel, because of natural human tendencies to operate directly purport only to further the district as such and actually carry on their daily duties much as if the district did not exist.

When it is considered that the first soil conservation districts law was not established in any State until 1937, that since that time nearly a quarter of a billion acres of land have been included within districts and, further, that districts are for the most part really running their own affairs, then there need be no genuine apprehension that the movement will not succeed. On the other hand, national crises, changes in points of view of representatives of assisting agencies, confusion or jealousies between agencies assisting districts, and any number of related considerations, may tend to disrupt or circumvent the true district philosophy and bring the death of this new and worthy democratic soil conservation movement. The soil conservation district approach to a widespread attack on the devastating forces of soil erosion and soil destruction is not without precedent in other countries; but its degree of success in the American way will be unmatched and unprecedented if allowed to continue along present trends and especially if it continues according to the real underlying principles which in their entirety constitute a distinct philosophy.

TIMBER AND CUT-OVER LAND PROBLEMS

(Continued from p. 155)

of Granite Falls. The seventh board member, appointed by the State director of agriculture to represent the public, is Prof. Bror L. Grondall of the University of Washington School of Forestry at Seattle.

President James himself has summed up the co-op's plans and goals effectively:

"The main thing was to make a start," he said. "If we can get things on a good working basis and prove to our members that we can be of service, in 4 or 5 years we may have five or six cooperatives in different counties. The average farmer knows very little about forests and forest products. For that reason, chiefly, we have organized and put ourselves in a position to make use of service available from foresters and soils men. Marketing troubles are particularly bad when the product isn't sought; that is, when the big grower has trouble, the little grower hasn't a chance at all. The buyers are beginning to have to go back farther and farther for their poles and certain other products; we should be able to help

them to supply their demands from nearby lands.

"As soon as a farmer begins to cash in on his forest, he will appreciate its worth. The main thing, then, is to find markets for his products. We need to appreciate the fact that forestry is not a hindrance to cultivation farming; it will be a help and will complement regular farming. I believe in the advantages of sustained yield, and that the forestry people can carry their point a lot farther through this association that talks sustained yield and backs them up."

PRACTICES IN PEACH ORCHARD

(Continued from p. 163)

it should be stated emphatically that in most instances these practices should be accompanied by contour planting and terracing as the fundamental basis for successful operation. Concentration of run-off under any but the most ideal conditions will tax most agronomic practices adapted to peach orchards beyond their normal effectiveness. Only through a combination of all phases of a coordinated erosion-control program shall we accomplish our ultimate objective in a practical manner.

For REFERENCE

Compiled by **ETTA G. ROGERS**, Publications Unit



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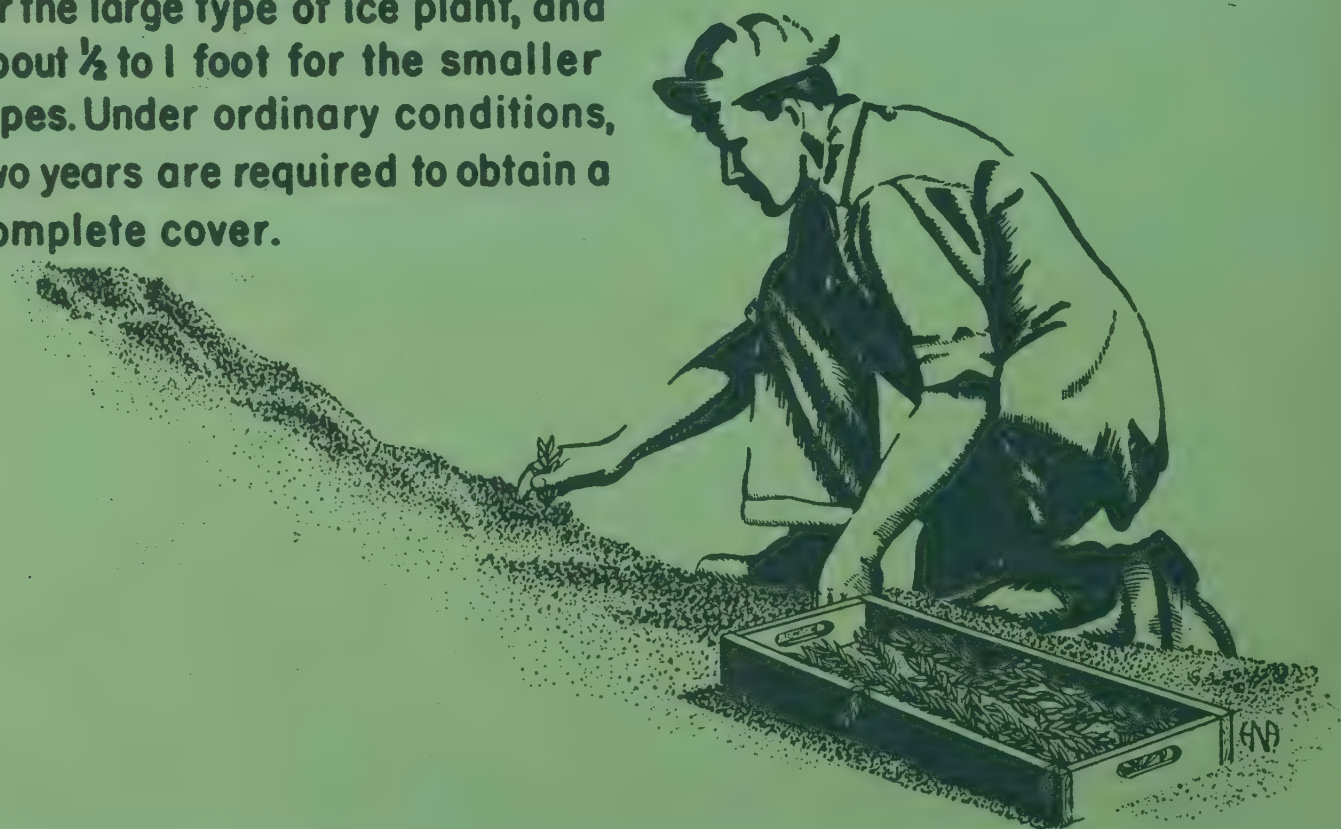
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The ice plant has been used by the Service for roadside and bank plantings to the extent of 60,000 cuttings during the past year in the Pacific Southwest Region. Plans call for the use of 100,000 this year. The species used are mostly broad or large-leaved types: Mesembryanthemum chilense, a native of California and Chile, and M. edule, a native of South Africa. The large species are not recommended for vertical planting on highway or other embankments, as the top growth becomes heavy and the roots are pulled out. M. roseum, a slower growing, mat-forming species, is sometimes used for steep banks and terraces.

Most species of the ice plant grow easily from seed or cuttings. Cuttings may be taken and plantings made at any time of the year. Cuttings usually consist of a matured piece of the branching stem of the parent plant (1 to 3 inches in length) together with the connecting foliage. The spacing of cuttings is from 1½ to 3 feet for the large type of ice plant, and about ½ to 1 foot for the smaller types. Under ordinary conditions, two years are required to obtain a complete cover.



JANUARY 1941

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SAVING SOIL AND
MAINTAINING INCOME

By David H. Walter



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
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WELLINGTON BRINK
 EDITOR

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HUGH H. BENNETT
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ECONOMIC CONSEQUENCE OF CONSERVATION

By S. W. ATKINS¹

THE adoption of recommended soil and water conservation measures by farmers often involves adjustments in the internal organization and operation of farms. That conservation measures are effective in the control of erosion is commonly accepted. There remains, however, the question of the probable effects on the immediate and future farm income.² The question is answered in this article insofar as it relates to one farm.

Howard Cooke's farm is located in the northeastern Piedmont of North Carolina. It is typical of the two-mule tobacco-cotton farms of that section. Mr. Cooke was one of the first farmers in the Cedar Creek demonstration area to inaugurate a cooperative conservation program when that project area was established in October 1935. The farm was in a badly run-down condition when he purchased it at a court sale in 1932. Sheet erosion had taken from 50 to 75 percent of the topsoil on all crop land. Gullies were active on a part of the cultivated area and on part of the woodland.

Mr. Cooke had made considerable progress in restoring the farm to its normal producing capacity prior to the establishment of the Soil Conservation Service program in 1936. At that time some idle crop land had been restored to the cultivated area, a small acreage of summer legumes was being grown for soil improvement and an attempt was being made to check erosion by mechanical means. However, no systematic crop rotation had been established; practically no winter cover crops were being grown; and the water disposal system was inadequate to control soil erosion. No permanent improved pasture was available (figure 1). Livestock was kept only for farm and home use.

In general the conservation plan for the farm consists of mechanical erosion control measures and adjustments in major land uses and in the cropping system. Some changes in livestock production are anticipated as a result of the changes in the kind and amount of feed produced under the new farm organization. The plan provides for mechanical erosion-control measures consisting of terraces and terrace outlets on all crop land; contour furrowing of the permanent pasture land, and contour tillage of all cultivated crops; and strip cropping on approximately half the crop land (figure 2).

One of the most significant proposed changes in land use is the shift of 11 acres of idle crop land to permanent pasture and to the cultivated crop area. The productive area of the farm in terms of crops and pasture is increased 20 percent by this change in land use.

The planned cropping system includes the establishment of systematic crop rotations, expansion of the acreage of winter cover crops, increase in the acreage of legumes for soil improvement, and the substitution of annual lespedeza for cowpeas and soybeans for hay and seed (table 1). Two major crop rotations are proposed—a 2-year rotation of flue-cured tobacco and rye, and a 4-year rotation of corn and/or cotton, oats, and lespedeza, with cowpeas interplanted in the corn. The latter rotation will be practiced principally on the strip-cropped area. A 2-year rotation of oats double-cropped with crotalaria, and corn interplanted with crotalaria, is planned for one field until normal productivity is restored. This field will then be included in

¹ Project supervisor, division of economic research, Southeastern Region, Soil Conservation Service, Raleigh, N. C.

² The Department of Agricultural Economics of the North Carolina Agricultural Experiment Station, the Soil Conservation Service, and the Bureau of Agricultural Economics of the U. S. Department of Agriculture are cooperating agencies in a State-wide project to determine economic consequences of planned programs of the Soil Conservation Service.

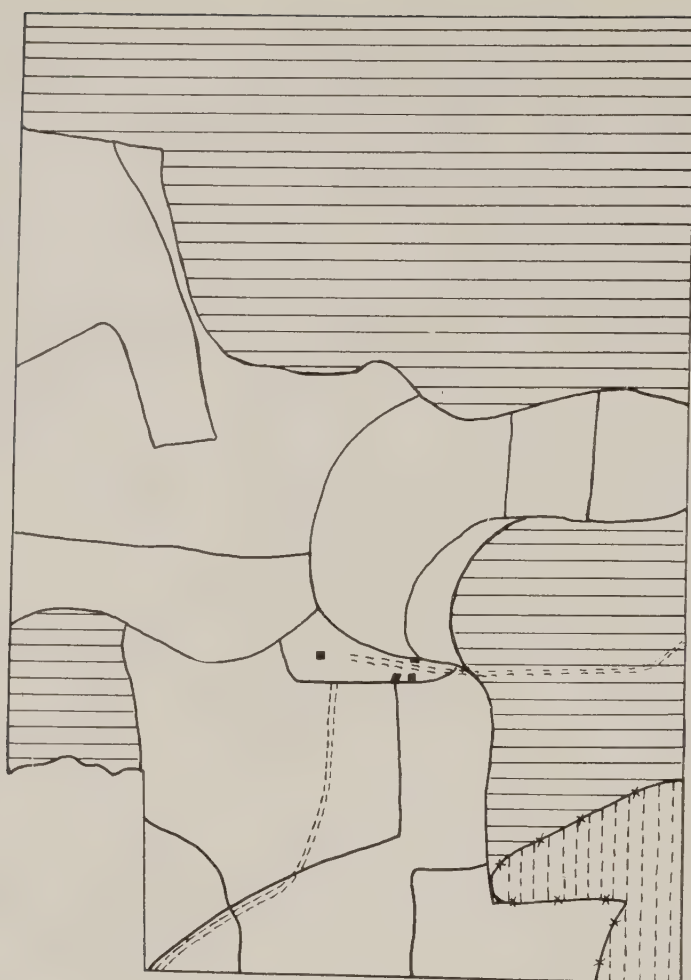


Figure 1. Farm Layout on a Tobacco-Cotton Farm in North Carolina
Before Replanned for Soil and Water Conservation

the 4-year rotation. No reduction in the acreage of tobacco is proposed. The planned reductions in the acreages of corn and cotton are not significant. Two acres of permanent hay will be introduced into the cropping system by the construction of meadow strips or grassed waterways. This device thus serves a dual purpose—as a source of hay and as protected terrace outlets.

No change in the livestock system is proposed except adjustment resulting directly from changes in land use and in the cropping system, namely, expansion of the hog enterprise and the addition of a few young cattle for grazing.

As was expected, the operation of this conservation program is bringing about many changes in the physical and economic conditions of the farm. Abundant evidence is available of physical conservation of the soil; gullies have disappeared, and sheet erosion has been reduced to a minimum. Economic effects to date are somewhat obscured by certain physical and economic factors affecting income and having no relation to the conservation program. Furthermore, sufficient time

has not elapsed for the full effects of the program to be reflected in net farm income. Therefore, it is necessary that we analyze the probable economic consequences while holding constant such variable factors as prices paid for factors of production and prices received for products sold.

Crop and livestock production, which are expected to increase in the aggregate under the conservation

TABLE 1.—Land use and crop production: Original system and soil conserving plan on a tobacco-cotton farm, Franklin County, N. C.

Land use	Number of acres		Yield per acre		Total production	
	Original system	Soil conserving plan	Original system	Soil conserving plan	Original system	Soil conserving plan
Row crops:	Acres	Acres				
Tobacco.....	8.0	8.0	Lb. 1,000	1,000	8,000	8,000
Cotton.....	4.0	3.6	Lb. (lint) .. 325	350	1,300	1,260
Corn.....	9.0	8.6	Bu. 21	30	190	258
Other.....	2.0	1.2				
Total row crops..	23.0	21.4				
Small grain:						
Oats.....	2.0	6.5	Bu. 15	25	30	160
Rye.....		8.0	Bu.	10		80
Hay:						
Cowpea-soybeans ..	7.0		Tons.....1.0		7.0	
Lespedeza.....		4.5	Tons.....	1.0		4.5
Meadow strip ..		2.0	Tons.....	1.0		2.0
Total hay.....	7.0	6.5	Tons.....		7.0	6.5
Cowpeas alone (seed)...	5.0		Bu. 8		40	
Cowpeas intertilled ..		7.9	Bu.	2		16
Lespedeza (seed).....	4.0	6.3	Lb.	250		1,575
Crotalaria.....		1.5				
Total acres in crops...	41.0	58.1				
Acres double-cropped and intertilled.	2.0	15.1				
Crop land harvested....	39.0	43.0				
Idle crop land.....	11.0					
Permanent pastures.....		7.0				
Woods pasture.....	3.0					
Other woods.....	47.0	50.0				
Other land.....	1.0	1.0				
Total operated...	101.0	101.0				

plan of farming, are important causal factors in the improved income over the previous system. The amount of concentrates produced for feed (corn and oats) is expected to increase approximately one-half in terms of corn equivalent. Increased production of corn is based entirely on anticipated increase in yields per acre (table 1).³ In addition to the expansion of the acreage of oats, yields per acre are expected to increase because of increased productivity of the soil and because of the shift from spring oats to winter oats. Crops available for hay—lespedeza and permanent hay—are almost doubled in acreage. However, the acreage of lespedeza above normal requirements for feed is to be harvested for seed by combining, and the

³ Future yield estimates are based in part on results of research on effects of cropping systems on yields at the North Carolina Experiment Station and results on this farm since 1935.

straw is to be left on the land for soil improvement. Rye for grain is a new enterprise. No change in tobacco production is proposed, and total cotton production is expected to be reduced about 5 percent.

Improved permanent pasture should provide grazing for at least four animal units for a minimum of 6 months each year, and an additional 2 or 3 months' pasture should be available for at least two animal units. In contrast, no pasture other than brush and broomsedge pasture was available under the previous farming system.

These proposed changes in feed crops and pasture are expected to result in adjustments in the kind and amount of livestock. The operator will expand the hog enterprise by adding a brood sow, and by increasing pork production from 500 pounds for home use to more than 2,000 pounds for home use and for market (table 2). This is made possible by anticipated increase in corn production and release of corn for hog feed made possible by the substitution of some oats and pasture for corn in the ration for work stock. To utilize surplus pasture, four yearling cattle will be grazed a minimum of 6 months. They are to be purchased in the early spring of each year. A net production of 800 pounds of beef is expected annually. The operator prefers this use of the surplus pasture to increasing the number of milk cows, mainly because of the lack of a convenient market for dairy products.

TABLE 2.—Livestock and livestock production: Original system and soil conserving plan

Item	Production		Number of head	
	Original system	Soil conserving plan	Original system	Soil conserving plan
Workstock.....number..			2	2
Cows.....gallons, milk..	450	700	1	1
Calves.....pounds, veal..	100	100	1	1
Other cattle.....pounds..		800		4
Sow.....number.....				1
Other hogs.....pounds..	500	2,250	2	10
Hens.....number.....			20	20
Eggs.....dozens..	250	250		

It is significant that soil conservation is accomplished under the new plan without any apparent unfavorable effect on long-time net income. While total expenditures are calculated to increase from \$803 to \$964 as a result of the operation of the conservation plan, cash farm income is expected to increase from \$2,327 to \$2,639. Thus, the added receipts are approximately double the additional expenses.

The calculated increase in gross farm income is the result for the most part of the proposed expansion of the hog and cattle enterprise. Cash receipts from

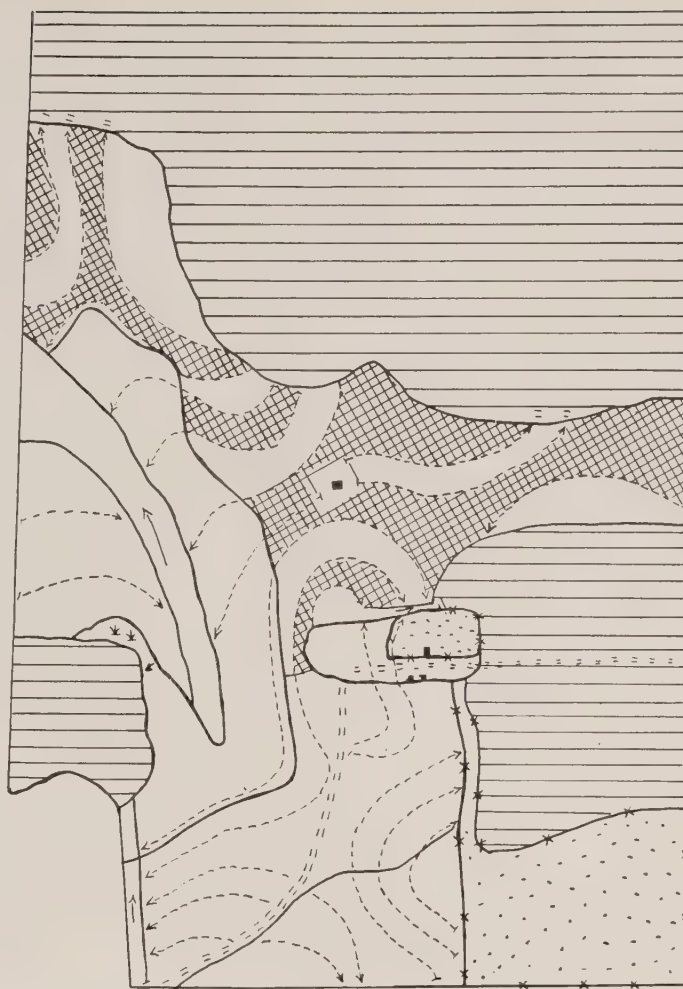


Figure 2. Farm Layout on a Tobacco-Cotton Farm in North Carolina
Replanned for Soil and Water Conservation

these combined enterprises account for \$221 of the aggregate increase of \$302 (table 3). The cash income from two new crop enterprises, rye and lespedeza seed, amount to \$140, but this increase is offset in part by reductions in income from cowpea seed, sweet potatoes, and cotton. While increased soil productivity resulting from conservation is reflected in farm income, as calculated, no attempt is made to estimate the value of a probable increase in productivity of the farm woodlot through improved forestry practices.

An analysis of changes in farm expenses reveals an increase in such operating costs as fertilizer, harvesting small grain and seed, feed, and certain livestock expenses other than feed (table 3). Additional costs are incurred for such fixed items of expense as depreciation and interest on investment. The increase in depreciation is the result of the purchase of additional machinery and improvement of buildings and pasture fence. Interest on investment is increased as a result of the real-estate improvements, expansion of the

livestock enterprise, and costs incurred in the establishment of such conservation measures as improved pasture, grassed waterways, crop rotations, wildlife plantings, and gully control.⁴

TABLE 3.—*Financial summary: Original system and soil-conserving plan*

Receipts			Expenses		
Item	Original system	Soil-conserving plan	Item	Original system	Soil-conserving plan
	Dollars	Dollars		Dollars	Dollars
Crops:			Fertilizer.....	205	239
Tobacco.....	2,000	2,000	Harvesting grain and seed.....	35	63
Cotton.....	193	185	Seed.....	9	.....
Rye.....	.....	70	Ginning cotton.....	9	9
Lespedeza seed.....	.....	70	Feed.....	23	34
Cowpeas.....	45	11	Other livestock expense.....	15	68
Other.....	51	32	Labor.....	350	350
Total crop receipts...	2,289	2,368	Auto farm use.....	45	45
Livestock:			Taxes.....	47	47
Hogs.....	.....	123	Depreciation.....	65	83
Cattle.....	8	98	Interest on improvements.....	.....	26
Dairy product.....	.....	25	Grand total...	803	964
Poultry product.....	30	30			
Total livestock receipts.....	38	276			
Grand total..	2,327	2,644			
Net return.....	1,524	1,680			
Increase in net returns: \$156, or 10 percent.					

Farm labor is the major item of variable expense not changed by the new farm plan. While hours of labor used is estimated to decrease slightly under the conservation program, the reduction will not be reflected in cash expenditures for labor. More important than the decrease in hours of labor used is the more uniform distribution of labor expected under the proposed plan. This results primarily from a shift from summer legumes to lespedeza and to a small reduction in cultivated crops, chiefly cotton. Maintenance and/or improvements of conservation facilities and practices can be accomplished without conflict with normal peak labor loads. For example, maintenance of terraces, pasture, and grassed waterways can be done chiefly during the early spring months. Thinning the woodlot stand can be accomplished in conjunction with cutting wood for curing tobacco. This practice requires little labor in addition to that used originally for cutting curing wood.

Conservation measures established on this farm during the first 4 years conform very closely to the proposed plan. All terraces and terrace outlets have been constructed. Terrace outlets were protected by spreaders and shrubs where needed. Improved permanent pasture has been constructed and contour

⁴ Terraces were constructed by farm labor and power at very little or no cash cost. This item was thus excluded from the calculation.

furrowed. Recommended maintenance practices are followed on terraces, terrace outlets, and permanent pasture. Contour tillage is practiced as originally recommended, except for a slight modification which was necessary to provide adequate drainage for tobacco. Strip cropping has been inaugurated on all land for which it was recommended. The principal modification made in the planned cropping system was the reduction in the acreage of corn and cotton below the acreage recommended. This change made possible a corresponding increase in the acreage of lespedeza for seed and for use in soil improvement. These adjustments in the cropping system were the result of relatively low prices of hogs and cotton and of the operator's desire to facilitate increase in the productivity of the soil. Increase of 50 percent or more in corn yields per acre to date indicate to some extent the success of this soil improvement program. The practice of harvesting small grain is lagging in part because of the operator's difficulty in getting a combine in the early years of the program.⁵ Oats are used in part for hay, and some rye is left on the land to be followed by tobacco the second year. Pigs, except those for home use, are now being marketed as feeders instead of market hogs. The farm poultry enterprise has been expanded slightly, because of relatively low prices of hogs and the farmer's preference for further diversification of livestock.

The program "in action" is decidedly in the direction of soil and water conservation. While the goal has been exceeded in some phases of the program, the complete program as proposed should be attained, with minor adjustments, in another 4-year period. Observation is adequate to reveal its success in terms of physical conservation; up to the present the annual farm records show no decrease in actual net farm income, which can be attributed to the operation of the planned program.

The success of the program to date may be attributed in no small part to Mr. Cooke's recognition of the need for conservation and to his capacity for putting the recommended plan into operation. It should be recognized, however, that certain other factors, such as freedom from mortgage debt and the availability of a relatively large crop area, are contributing factors. Also, net farm income was adequate to provide funds necessary for establishing the conservation program.

⁵ This difficulty does not exist now, as several combines are available in the area.

In the next issue: District Operation From a Supervisor's Standpoint, by F. S. Hurd.



Churches prosper as Conservation comes to the land

By Charles G. Webb¹

WISE land use has a moral and spiritual value. Soil conservation gives new life to rural communities and their churches.

Reliable economic surveys in demonstration projects already have indicated that conservation farming practices usually tend to increase farm income. But these surveys of material benefits do not include the intangible values of soil saving.

As an example of the economic benefits to be obtained from conservation farming practices, the Duck Creek Demonstration Project of the Soil Conservation Service near Lindale, Smith County, Tex., is sometimes cited.

Since 1935, when the demonstration project was getting under way at Lindale, economic studies have been made on two groups of farms. One group received the assistance of the Soil Conservation Service in the establishment of conservation practices, and one group did not. The two sets of farms were as nearly similar as possible: alike as to size, soil types, topography, cropping systems, distance from markets, managerial ability of operators, and so forth. During the 5-year period ending 1939, the conservation farmers received an average of \$2,406 in net farm income, while

1. Virgil Stone home, rebuilt by conservation farming.

2. First came better land use, then the rebuilding of this home of Mr. and Mrs. I. L. Pool.

3. From a sounder agriculture came the funds with which to rebuild the Methodist Church building and pay for a new Sunday-school room.

4. An artist's sketch of Carmel Baptist Church, rebuilt and reinvigorated as soils are saved.

their neighbors, who continued to use the old methods, received only \$1,360 each in net farm income. Here was a difference of \$1,046 in favor of conservation farming in 5 years.

Have the churches in the Duck Creek watershed benefited, too?

For an answer to that question I talked with I. J. Hall, who has been treasurer of the Carmel Baptist Church in the watershed for 9 years, and with Miss Lillian Sharman, church clerk since 1931. And here is the story summarized:

In 1934 Carmel Baptist Church had no pastor, had 72 members, and received offerings of only \$47. The church building, constructed in 1876 and last remodeled in 1908, was in a sad state of repair. In 1939 the church had a regular pastor, the Reverend Mr. A. W. Coltharp, had 104 members, and received offerings totaling \$711.49. During 1939 the members spent \$551.25, plus labor which they donated, to construct a new church building.

During that period from 1934 to 1939, the church

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membership had increased 44 percent and the offerings had increased approximately 1,400 percent.

This evaluation of the benefits the church received, based on members and offerings, does not tell the whole story any more than the economic surveys did.

What is more important is the attitude of the members. In the words of Mr. Hall:

"Before we obtained a regular minister and improved our building, some of our people were moving their memberships to town and some of them weren't going to church anywhere. Our people are now staying in their home community to worship.

"We pay our minister \$10 a month. He preaches one week end each month—Saturday night, Sunday morning, and Sunday night. A few years ago it was hard to collect \$10 to pay a minister, but now the people don't wait for you to ask them to help pay the preacher. They come around and ask to help."

As Miss Sharman expressed it:

"We could have done more for our church every year, even back in 1934, but we just didn't."

Why didn't the members of Carmel Baptist Church give greater support to their church? First, let's examine the condition of the land and the economic condition of the people in Duck Creek watershed in 1934; then let's consider briefly a few historical and Biblical references. Perhaps we can thus find the answer.

Conservation surveys of the farms in the Duck Creek watershed disclosed that in 1934 at least one-third of the original topsoil had been removed by erosion. Because only the topsoil can be farmed profitably, it naturally follows that the landowners in the watershed had lost one-third of their original capital investment in the land. The per acre production of the two principal cash crops was low; in 1934, the average lint cotton production on the 187 farms in the watershed was 113 pounds per acre and the average corn yield was 5.2 bushels per acre. These low yields were further evidence of the approaching depletion of soil resources. Low yields and low prices for farm products were reflected in the poor economic conditions. In 1934, the average net farm income on the 187 farms was \$130. Fences, buildings, and equipment were run-down, and the farm work animals were old.

From time immemorial people have drifted from the church and its teachings when they no longer have the necessities of life. When the Israelites were hungry and in the wilderness, they pleaded to return to Egyptian slavery where at least they would be fed. In Exodus 16:2 we find this statement, "The whole congregation of the children of Israel murmured . . ."

History is filled with the records of civilizations

which have fallen because of a demoralized agriculture. In Northern Africa and Syria, for example, there are ruins today of civilizations which were completely wiped out because the people permitted the soil to wash or blow away. And unproductive soil will support neither a people nor such institutions of civilization as churches and schools.

In contrast with the low farm income and low crop yields of 1934, consider the income and yields from the conservation-treated farms in 1939. Conservation farmers in 1939 had an average net farm income, including A. A. A. payments, of \$490, nearly four times as great as the net farm income they had in 1934. Cotton yields on these farms in 1939 averaged 159.5 pounds of lint per acre and the corn production averaged 12.4 bushels per acre. Those figures represent an increase of more than 41 percent in the cotton yields and of more than 138 percent in the corn yields. The remainder of the increase in income as compared with 1934 was due to the increase in prices over the 5-year period brought about by general economic improvement and the price-supporting measures carried on by the Department of Agriculture. During the past 5 years of conservation farming, the cooperators of the Soil Conservation Service have averaged 155.8 pounds of lint cotton per acre and 11.5 bushels of corn per acre.

People whose lands are productive, whose income is sufficient to provide them with the necessities of life and who find hope and opportunity in their lands and their markets, are more able to support their churches, their schools, and their other community enterprises. There is a feeling of security and peace which comes to the man whose land pays him well for good stewardship. In the Bible it is said, "But they shall sit every man under his vine and under his fig tree; and none shall make them afraid."

"Material, social and religious prosperity usually go hand-in-hand," said the Reverend Mr. Coltharp, "and it's largely that way in the Carmel community. Our people now have more to do with. They have more hope, more security, and more opportunity, but they must work hard. It's a 6-day-a-week job. This land should have been protected 65 or 70 years ago, and our people have to work harder now because the land wasn't protected."

The conservation farmers of the Duck Creek watershed don't have any more topsoil than they had in 1934. But they are using wisely the topsoil remaining. They are protecting it from soil erosion. They are improving it by the use of proper crop rotations, which include legumes. If these farmers do not preserve and improve this land, if they are not good

stewards, they know that their children will have less opportunity to earn a living from the soil.

And the land has responded. In 1939, Mr. Hall said he harvested 35 bales of cotton from 33 acres, as compared with an average of one-third of a bale per acre before he began conservation farming. The improved pastures on his farm have enabled him to increase the number of cows from 3 in 1934 to 10, and there's grass enough in the pastures to carry 25 cows through the grazing season. Where formerly Mr. Hall's principal cash crop was cotton, he now has an added source of income from cattle. He estimated that he sells \$150 worth of whole milk each year. Last spring he sold 4 cows at \$35 each, and replaced them with young and better grade animals. He is growing all the feed needed for his livestock.

Farm homes throughout the Duck Creek watershed reflect the fact that better days have come to the community. Virgil Stone, I. L. Pool, and C. W. Flewellen have rebuilt old residences. The Stone residence, built by Mr. Stone's grandfather shortly after the War between the States, was so run down that Mr. and Mrs. Stone did not live on their farm until they were able to rebuild. New homes have been erected by Park York, R. W. Copeland, and S. H. Ferguson. W. O. Smith has put up a new tenant house, and J. R. Bowdoin has reroofed three tenant houses. There are new roofs, new paint, or both, on the residences of George Lake, Mr. Hall, B. A. Elliott, Mrs. M. F. Hall, W. T. Copeland, J. A. Johnson, Mrs. H. A. Bowdoin, and the late Miss Zelda Copeland.

Mr. Pool, a steward of the Methodist Church in the Duck Creek watershed, also cited improvements which had been made to his church. In 1936 the members spent \$530 in rebuilding. In 1937 a \$200 Sunday School room was built with the help of the Methodist Church's Board of Church Extension. The members contributed the labor.

"It's a good deal easier now to raise salaries and conference claims for our church than it was several years ago, but I don't think we can give all the credit to conservation farming or to A. A. A. loans and payments," Mr. Pool said.

"But we know what will happen if we permit our land to wash away," he continued. "Everyone will be forced to leave, because it is no longer possible to make a living. Naturally, that would mean the death of our rural community and our rural church."

Mr. Pool said he had seen many desirable land-use adjustments made in the watershed as a result of conservation farming.

"This county was cottoned to death and the land was washing away," he explained. "Most of the farmers couldn't start a crop each year until they had bought feed. Now our farmers are raising feed for their livestock."

A complete and coordinated conservation farming system, such as the cooperating farmers of the Duck Creek watershed established, provides for the treatment of every farm acre according to its needs and capabilities. Steep and severely eroded land which was neither safe nor profitable in cotton and corn was retired to grass or trees. Old pastures were improved to control erosion. Consequently, there is more forage available for livestock. The adoption of proper crop rotations has increased the production of feed crops.

Mr. Pool has been operating his 100-acre farm 42 years. Fields in which there were gullies 40 years ago have been protected from soil erosion, and today this land, which has been in cultivation since the War between the States, is producing profitable crops.

And such land—even 100 acres, the size of Mr. Pool's farm—means security and opportunity for a family. All of the nine children of Mr. and Mrs. Pool are high school graduates; seven also are college graduates, and one is now attending college.

Conservation farming is nothing less than obedience to the natural laws stated in the beginning by the Creator.

LOW-COUMARIN SWEETCLOVER

Sweetclover is one of the important legumes being used under certain conditions in soil conservation work. Abundant seeding, vigorous growth, the occurrence of nitrogen-fixing bacteria on its roots and its value in pastures are among its most important qualities. However, it is not palatable to stock that are unaccustomed to it, on account of the bitter taste arising from the coumarin it contains.

A low-coumarin strain of sweetclover has been licensed in Canada as the variety "Pioneer." It will be increased under contract in 1940-41. The development of this new strain is described by T. M. Stevenson and W. J. White of the Experimental Farms Service, Ottawa, Ontario, in *Scientific Agriculture*, Vol. XXI, September 1940, pp. 18-28. This strain of sweetclover has a coumarin content varying from zero to 0.05 percent and averages around 0.02 percent, which is about one-tenth as much as the average in unselected material.

FARMER EVALUATION OF CONSERVATION PRACTICES IN SOUTHERN PLAINS

By H. H. FINNELL ¹ AND THEODORE A. NEUBAUER ²

FARMERS are very good at choosing conservation practices according to needs and usefulness, when a complete program is offered them. This is one conclusion to be derived from a recent study of farmer evaluation and criticism of conservation practices in the Southern Great Plains Region. An analysis of the results of a survey made by the Soil Conservation Service shows that 88.6 percent of the farmer cooperators reported an increase in the value of their farms as a result of installing a conservation program; 80.4 percent reported a net increase in farm income as a result of practicing conservation; 95 percent expressed their intention of continuing the program after the expiration of their cooperative agreements; and 70.4 percent expressed the opinion that none of the practices recommended by the Service should be eliminated from the conservation program.

Questionnaires were mailed to 4,200 cooperating farmers and ranchers, some of whom had been cooperators with the Service for as long as 6 years. The summary of the 2,257 replies, in which practices were listed in the order of their value to the farmer, affords at least a preliminary evaluation based on practical experience. The popularity of the different conservation practices for the region as a whole may be appreciated by noting their general rank in the accompanying table. Contour farming, terracing and gully control, the three most valued practices, all have to do with the management and control of water on cropland, excepting only gully control practices as used in the grazing areas. It probably is significant that the next three ranking practices—grazing control, pasture furrowing and stock water ponds—all have to do with grazing land.

As would be expected, farmer opinion shows a tendency to conform to climatic and type-of-farming belts. The areas of the Southern Great Plains Region fall roughly into three rainfall belts, 12 to 18 inches, 18 to 24 inches, and 24 to 36 inches. The low-rainfall belt includes eastern New Mexico and eastern Colorado; the middle belt, the high plains of Texas and Oklahoma and the western half of Kansas; and the high-rainfall belt includes the eastern half of Kansas.

Value of conservation practices as reported by farmers in rainfall belts of Region 6, 1940

Practices	Total farmers reporting from Region 6	Reports from rainfall belt 24 to 36 inches	Reports from rainfall belt 18 to 24 inches	Reports from rainfall belt 12 to 18 inches
	Percent	Percent	Percent	Percent
Contour farming.....	74.6	76.1	83.9	56.7
Terracing.....	58.1	76.8	59.0	24.5
Gully control.....	49.4	80.7	23.8	38.5
Grazing control.....	43.3	42.2	34.9	59.6
Pasture furrowing.....	39.7	29.3	41.3	55.1
Stock water ponds.....	38.6	43.9	24.4	53.4
Cropping system.....	35.1	46.4	30.6	23.5
Water diversions.....	33.5	42.7	22.8	35.1
Tree planting.....	30.6	39.2	19.5	33.8
Strip cropping.....	29.9	24.0	36.5	28.3
Cover cropping.....	27.1	16.4	36.8	29.9
Wildlife development.....	14.7	17.8	10.6	16.2
Revegetation.....	13.8	12.8	11.9	18.5
Border plantings.....	11.5	7.7	18.3	6.6
Miscellaneous.....	3.6	3.3	4.5	3.2
Total number of reports received.....	2, 257	857	839	561

The central belt contains most of the flat plains area of even topography. Both to the east and to the west lie belts of significantly more rolling topography, one with greater rainfall, the other with less. Considering the different combinations of land use and water relations to soil, it is to be expected that different practices would be more valuable in different areas.

The change of emphasis between rainfall belts is marked. The preferred six practices in the low-rainfall or western belt are grazing control, contour farming, pasture furrowing, stock water ponds, gully control and water diversions, in the order named. Contour farming, terracing, pasture furrowing, cover cropping, strip cropping, and grazing control are the conservation practices considered most valuable in the middle rainfall belt; while in the highest-rainfall belt they are gully control, terracing, contour farming, improved cropping systems, stock water ponds and water diversions, in the order named.

Terracing and improved cropping declined in importance in passing from wetter to drier areas. On the other hand, pasture furrowing steadily increased in importance toward the drier areas. All the other practices listed arranged themselves into two groups. Contour farming, strip cropping, cover cropping, and border plantings were of greater importance in the middle, or plains, belt than in the areas either to the east or west. Gully control, grazing control, stock

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water ponds, water diversions, tree planting, wildlife development, and revegetation were found to be of lesser importance in the middle belt than either to the east or west. Two practices owed their importance in the extreme eastern and western parts of the region to opposite conditions. Water diversions, for example, were important in the 24- to 36-inch rainfall belt mainly as a means of disposing of excess water threatening gully formation largely on crop land; whereas in the 12- to 18-inch rainfall belt water diversions were important for collecting surface water to be used for flood irrigation largely on range land. Nine other conservation practices were considered more important than water diversions in the middle rainfall belt.

Gully control work was rated as of first importance in the high-rainfall belt where much of the gully problem exists on cultivated land that has been used intensively for the production of high-value types of crops not naturally resistant to erosion. On the other hand, gully control received a relatively high rank in the low-rainfall belt, but here it is applied mainly on grazing land where the natural vegetation is so sparse that its effectiveness for erosion control is quickly reduced by overgrazing. Eight other conservation practices were considered more valuable than gully control in the middle rainfall belt.

It is significant that the majority of those practices showing an upward trend toward the middle of the region had to do with crop management—namely, strip cropping, cover cropping, and border plantings. Probably contour farming and terracing are found at the top of the list for the whole region because they are the practices most generally used with profit throughout the region.

The nearly two-thirds of the total area of the region being devoted to livestock production accounts for the relatively high rank of important grazing land practices. That the livestock industry in Region 6 is di-

vided through the center by a great belt where crop farming interest predominates is shown by the fact that stock water ponds were highly valued by 44 percent of all cooperators in the eastern half of Kansas, 53 percent along the western side of the region, while only 24 percent mentioned them through the central portion of the region. The number of cooperators placing a high value on ponds in eastern Kansas is increased no doubt by the scarcity of ground water in some localities.

Other less universally applicable practices, appearing in the lower half of the group, such as water diversion, tree planting, strip cropping, cover cropping, wildlife development, revegetation and border plantings, are not necessarily less valuable than other practices, but apparently they are less frequently applicable and hence do not appear in all conservation plans. In fact, these data do not form a basis for evaluating the comparative merits of practices because the distribution of experience with all practices was not uniform among all farmers reporting. After all, very few if any of the practices are competitive with other practices; rather, each fits into certain conditions of need and operates with other practices to cross-brace the general structure of the conservation plan.

The applicability of conservation practices to the region as a whole appears to be affected mainly by two factors, water and grass. Water is a factor because of the need for it in relation to the land use and the possibilities of improving the efficiency of its utilization. Grass is a factor because of the predominance of grazing land use which exists partly because of limitation of use capabilities and partly because of incomplete land-use development.

Significant trends between rainfall belts, shown by the farmers' preference for different conservation practices, are consistent with existing land and land-use conditions. This indicates a discernment and acceptance of limiting factors by farmers.

“THE MAXIMUM EXERCISE OF INITIATIVE”

The soil conservation districts are local units of government, organized under State laws and answerable to the State legislatures. They operate, in most cases, over naturally bounded areas, and come into existence only in response to the petition and favorable referendum vote of the landowners and operators carrying on agricultural operations within their boundaries. In this way the necessary basis has been laid for the maximum exercise of initiative and responsibility by the farmers themselves.

The philosophy of democratic government revolves around the principle that the mass of the people is capable of governing. It is my conviction that a democracy, therefore, cannot be said to be succeeding unless the mass of the people participates in the affairs of government. Only their participation makes a democracy work. The distinguishing characteristic of the districts' legislation is that this principle is uppermost; these State laws place the responsibility for the management of a soil conservation program upon local folk.—*Claude R. Wickard, Secretary of Agriculture, in a statement dated September 21, 1940.*

SAVING SOIL AND MAINTAINING INCOME

By DAVID H. WALTER ¹

SINCE most farmers are primarily interested in obtaining a living from their land, the cost of adopting erosion control practices and their effect upon net returns will likely determine the extent of cooperation. Although the greatest returns over a period of years may be most desirable, the farmer will place major importance upon current returns, especially in areas where the margin between receipts and expenses is very small. It is hoped that this analysis of more or less preliminary survey data will help in settling the question of farm income as related to the establishment of a soil conservation program.

The first project in Pennsylvania for demonstrating erosion control practices on privately owned land, under the direction of the Soil Conservation Service, was established late in 1934 in the Crooked Creek watershed of Indiana and Armstrong Counties. In an effort to determine the effects of this program upon land use, crop production, and especially upon income, detailed survey records were obtained for 106 farms for the years 1934, 1936, and 1938.² Forty-eight of these farms are now cooperating in the program, having entered into their agreements either in 1935 or early in 1936. The last survey, therefore, would include the data for either the third or fourth crop year under the planned agreement.

The data for the 3 years indicate that by the adoption of some of the soil conservation practices for this area, considering all costs, the average labor income was decreased in 1936 during the period of establishing that program, but in 1938 when the program was almost completed, the labor income was increased to a point higher than it would have been if the program had not been adopted. Can these gains be ascribed to the soil conservation program? Will they continue? Fortunately, the basic data for 1934 are available and this affords an opportunity to determine by future studies whether the advantage gained in income by 1938 on cooperating farms will be maintained, increased, or decreased.

These two groups of farms, cooperating and non-cooperating, are very similar in respect to size, total investment, type of farm, location over the watershed

area, percent of tenancy, and age of operator. In 1934 they were all classed as full-time farms, and during the period covered by this study not one change in ownership was reported.

Most of the land is on rolling to steep slopes. The soils are mostly shallow and relatively low in productivity even where little or no erosion has taken place. The relative productiveness of the land is about average for the State or slightly below. Survey data show that more than half of the original topsoil has been lost from the cleared land. A few of the local farmers had adopted a system of strip cropping for erosion control prior to 1934, but the common practice was to plant large fields to a single crop. In 1934, the average size of the 48 cooperating farms was 108 acres. Of this, 13 acres were in woods, 24 in permanent pasture, 52 in crops, and 19 acres in "other land" which was mostly idle cleared land. About 12 acres were used for clean tilled crops, 19 acres for small grain crops, and 19 acres for hay. The land use on noncooperating farms was similar to that on cooperating farms.

The soil conservation program, in general, calls for contour strip cropping, reforesting steep slopes and badly eroded land, protection of old woods from grazing, improvement of some hay and pasture land by the application of lime, seed, and fertilizer, an increase in the acreage of hay, a decrease in the acreage of grain and row crops, and certain structures, such as diversion ditches and contour furrows, for the control of excess water.

Land-Use Changes

Practically every one of the 48 cooperating farms included in the study has followed rather closely the major changes as planned in the farm layout and field arrangement. Acreage changes were not as great as might be expected. Both cooperators and non-cooperators decreased their crop area by 2.7 acres and increased permanent pasture by 5 acres. The reforestation program was responsible for an increase of 5 acres in young plantings on the cooperators' farms.

Although the total crop acres on noncooperating farms was reduced, the proportion of the total crop land area in hay, and in grain and row crops, remained about the same. A decided shift to a higher proportion in hay and a smaller proportion in grain and row crops was reported on cooperating farms.

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² Cooperative research project in the economics of soil conservation between the Soil Conservation Service and Bureau of Agricultural Economics of the United States Department of Agriculture, and the Department of Agricultural Economics of the Pennsylvania State College.



Contour strip cropping on the farm of G. Stephen Edwards, Indiana County, Pa.

As planned in the agreements, the acreage of grain and row crops for 1938 was 3.6 acres per farm less than in 1934.

Hay acreage on the cooperating farms was to be increased 10.2 acres per farm by 1938, but the survey data showed only a 2.2 acreage increase. Low prices, failure of their grass seeding, and no use for the additional hay, were reasons given by some of the operators regarding failure to reach the planned acreage. Another reason was that much of the hay land planned for three or more years without reseeding was of very low quality after the second year, and on a number of farms it was not harvested.

Average crop yields on both cooperating and non-cooperating farms were lower in 1938 than in 1934, but yields on cooperators' farms decreased only 1 percent compared to a 6-percent decrease in the other group. A change in yields over such a short period of time can hardly be attributed to saving or losing soil. Three factors probably were responsible for the relatively better yields on cooperators' farms. First was the probable saving of moisture by adoption of contour strip cropping; the soils are shallow and plant growth is quickly affected during dry periods. Second is the increased amounts of lime, manure and fertilizer used per acre of crops. Third, and probably the most im-

portant, was the shift in land use, such as using the poorest crop land for pasture or reforestation.

An important consideration in planning land use and crop acreage changes is the effect upon feed production, especially in an area such as this where practically all crops are fed. Grain production was reduced slightly on cooperators' farms, but increased a little on non-cooperators' farms. Roughage production in 1938 increased over 1934 figures for both groups, but increased considerably more on cooperating farms. On a percentage basis, the cooperators increased production of total digestible nutrients 9 percent as compared with an increase of 7 percent for the noncooperators. These figures show that feed production was maintained after desirable shifts had been made in land use, although some shift to more roughage and less grain was involved.

Most pastures are idle or abandoned crop fields that have not been limed or fertilized since the last crop was grown. At least part of the pasture land on all of the 48 cooperating farms received treatment with lime and fertilizer since 1934. In addition, an increase in acreage and favorable shifts in land use have resulted in considerably more available pasture feed per farm. Very little change in pasture treatment has taken place during this time on the noncooperating farms.

Changes in the number of livestock were very similar for both groups of farms. Numbers of dairy cows declined slightly, work animals and poultry remained about the same. Between April 1, 1938, and April 1, 1939, numbers of young cattle doubled on cooperators' farms and increased 50 percent on noncooperators' farms.

The increase in young stock is an indication that these farmers are utilizing, at least in part, the increased hay production and better pastures. Most dairymen in this section raise their own replacements for the herd. If present hay and pasture production are maintained or increased, the trend toward more dairying will be encouraged, especially if price relationships are favorable.

One of the most significant changes on cooperating farms has been the increase in milk production per cow. Twenty-one farms that sold whole milk continuously from 1934 to 1938 showed an average increase per cow of 1,000 pounds, or a change from 4,500 pounds to 5,500 pounds (table 1). Part of this change may be because of replacements by better cows and feeding about 175 pounds more of purchased concentrates per cow in 1938 than in 1934 on these 21 farms, but much of it is probably due to more and higher quality hay and pasture. Production per cow of noncooperating farms remained practically the same.

TABLE 1.—Milk production per cow in 1934 and in 1938 for farms selling whole milk

Item	21 cooperating farms		15 noncooperating farms	
	1934	1938	1934	1938
Number of cows.....	8.8	8.4	9.4	8.8
Milk production per cow.....cwt..	45	55	49	49
Price of milk per cwt.....dollars..	2.18	2.17	2.25	2.26
Cattle increase and net sales per cattle unit.....dollars..	10	18	11	14
Labor income.....do.....	60	334	361	211

Cost of Labor

Labor costs and the efficiency of man labor on the two groups of farms indicate that the cooperating farmers have not experienced any increase in labor costs because of the program, but instead have lowered costs and improved efficiency. However, in this area where most farm businesses are small with a large local fluctuation in industrial employment, primarily in the soft coal mines, a comparison of labor costs is not a satisfactory measuring stick of the change in efficiency resulting from the new farm layout. Members of the family are often used inefficiently on the farm between periods of employment elsewhere.

Assuming no change in labor efficiency and using established standards for growing crops and caring for livestock, it took 28 days less time to do the productive work on the cooperating farms in 1938 than in 1934. This decrease was made possible by a decrease in total crop acres, a shift to more hay and less grain, and a slight decrease in number of cows.

Farm Returns

A comparison of receipts on the two groups of farms shows that *gross income* was about the same for both groups in 1934 but that the cooperators increased their gross income from 1934 to 1938 by \$181 more than the noncooperators (table 2). About two-thirds of this was from the dairy and resulted from increased production per cow and increased numbers of young cattle. The increase in income from sale and appreciation of dairy cattle, however, was more than the increase from the sale of dairy products. Both groups showed a decline in income from crops, chiefly because of a reduction in potato acreage and a lower price for hay. Cooperators received larger A. A. A. payments and made a greater increase in nonfarm income, which was mostly from day labor off the farm.

Gross expenses increased slightly more on noncooperating than cooperating farms from 1934 to 1938. Cooperators reported a decrease of \$20 for labor and an increase of \$16 for feed and \$68 for lime and fertilizer per farm, while noncooperators reported increases of \$19 for labor, \$45 for feed, and \$30 for lime and fertilizer. Very little difference was found in the other expense items.

Labor incomes on 48 cooperating farms increased \$128 from 1934 to 1938, while on the 58 noncooperating farms labor incomes increased only \$9. The net increase in labor income in favor of the cooperators was \$119. It must be remembered, however, that the data presented thus far have shown a comparison between 1938, a year after the program had become quite well established, and 1934, a year when none of the farmers was cooperating in the program. A very important consideration is the effect on incomes during the first few years should the farmer adopt the program without assistance in materials and labor.

Between 1934 and 1936, labor incomes on cooperating farms increased \$48, while the labor incomes on noncooperating farms increased \$131—an advantage for the noncooperating farms of \$83 after deducting all contributions (\$142 per farm) from the Government (table 3).

When grouped by type of farm, the cooperators in all cases averaged a greater increase in labor income from

TABLE 2.—Receipts in 1934, and change from 1934 to 1938 on 48 farms cooperating and 58 farms not cooperating with the Soil Conservation Service

Source of receipt	Receipts per farm, 1934		Change in receipts, 1934 to 1938	
	48 co-operating	58 non-cooperating	48 co-operating	58 non-cooperating
	Dollars	Dollars	Dollars	Dollars
Dairy.....	595	501	146	32
Poultry.....	202	253	95	92
All other livestock.....	102	92	23	23
Crops.....	111	130	-19	-39
Miscellaneous farm.....	38	49	35	34
Miscellaneous nonfarm.....	52	48	7	-12
Agricultural conservation payments.....	0	2	43	19
Total.....	1, 100	1, 075	330	149

TABLE 3.—Change in labor incomes between 1934 and 1936 and between 1934 and 1938 on 48 farms cooperating and on 58 farms not cooperating with the Soil Conservation Service ¹

Farms	Labor income			Change	
	1934	1936	1938	1934 to 1936	1934 to 1938
	Dollars	Dollars	Dollars	Dollars	Dollars
Cooperating.....	-132	-84	-4	48	128
Noncooperating.....	-38	93	-29	131	9

¹ Cost of Government contributions from the 2 conservation programs is charged as an expense in these calculations.

TABLE 4.—Labor income on 102 farms in 1934 and in 1938 by type of farm and by cooperation with the Soil Conservation Service

Item	Dairy		Poultry		General	
	Cooperating	Noncooperating	Cooperating	Noncooperating	Cooperating	Noncooperating
Number of farms.....	29	27	3	8	15	20
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Agricultural conservation program payments, 1934.....	46	20	21	19	44	24
Cost of Soil Conservation Service program chargeable to 1938.....	34	0	30	0	30	0
Labor income in 1938 after deducting Government contributions.....	118	-28	-44	-67	-227	21
Labor income, 1934.....	-41	-16	-120	-68	-303	-44
Change in labor income from 1934 to 1938.....	159	-12	76	1	76	65
Net increase for Soil Conservation Service cooperators.....	171	.....	75	.....	11	.....

1934 to 1938 (table 4). As might be expected, the dairy farms made the greatest increase, probably because of their ability to utilize more advantageously the increased production of hay and pasture. Possible future adjustments between changed feed production and livestock may result in more equal advantages in labor income to the different types of farms.

Very little, if any, of the increase in income on cooperating farms from 1934 to 1938 can be attributed to saving the soil over such a short period of time; but it can be attributed primarily to the changes in land use and farm management practices on these farms. These farmers operated under the recommended soil conserving system and at the same time maintained their income after the program was established. Of much greater importance is the fact that the farm has been

placed on a more permanent productive basis by a land-use plan that will reduce soil losses.

Some of the changes on cooperating farms over the 4-year period can be attributed directly to the program. On the other hand, further study will be necessary to determine the cause of others and whether they are of a temporary or of a permanent nature. The significant changes on the average cooperating farm are those listed below:

1. An increase in hay acreage and a decrease in cultivated and small grain crops.
2. An increase of 5 acres in young forest plantings.
3. A higher percentage of legume hay, particularly alfalfa.
4. Use of more lime and fertilizer, especially on pasture.
5. A slight decrease in total production of grain feed and a considerable increase in total production of roughage.
6. Increase in number of young cattle.
7. Increase in pounds of milk produced per cow.
8. Increase in receipts from dairy cattle and dairy products.
9. Increase in lime and fertilizer costs, but a decrease in labor costs.

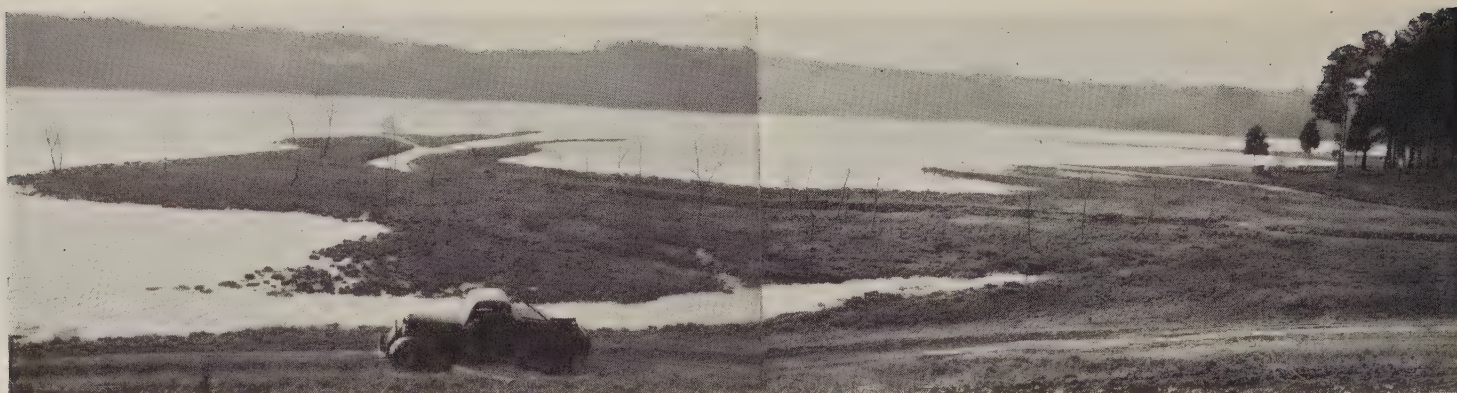
SPECIAL ANNOUNCEMENT

The next issue of SOIL CONSERVATION tells of the plans, progress, and performance of soil conservation districts.

Farmers speak of the meaning of districts to themselves, their neighbors, their communities. Supervisors give the inside story of problems met, opportunities embraced. Financiers relate sound banking to sound districts.

Straight from the grass roots of a great farm movement comes this convincing assembly of experiences, ideas, methods, comments, charts, maps, and halftones. You'll want to read it from cover to cover.

—THE EDITOR.



Panorama of delta of sediment deposited in Lake Raleigh from small tributary.

SOIL EROSION DAMAGES PUBLIC WATER SUPPLY

By ALEXIS N. GARIN ¹

SOIL Conservation Service workers have long recognized that soil erosion not only destroys farm and other lands but also causes severe damages to water-storage reservoirs and particularly to municipal water supplies. Numerous physical surveys have shown the extent of storage loss in reservoirs, but until recently no attempt has been made to appraise the physical damage from an economic standpoint. A study conducted jointly by the Soil Conservation Service and the North Carolina Agricultural Experiment Station, covering 28 municipalities, representing 90 percent of the water supply reservoirs in the State and 98 percent of those found in the Piedmont area, has determined that the costs resulting from losses of storage capacity are appreciable and that the additional costs of clarifying or desilting the water for domestic and industrial use also are significant.

The two items above mentioned (1) the financial burden placed on municipalities in terms of the expense for filtering or desilting the incoming water for public use, and (2) the burden placed upon the municipalities in terms of the depletion of the reservoir storage capacity of the municipal water supply systems, are discussed in some detail in this article.

Cost of Water Purification

An examination of filter plant and settling basin records shows that water carrying only a nominal supply of sediment requires less chemicals for purification than water that carries excessive quantities, especially of colloidal matter. A definite correlation exists between turbidity and the amount of alum, the

principal coagulant used by most cities in water purification. The amount of alum used frequently varies more than 50 percent between maximum and minimum turbidity. An examination of individual municipal water plant records will reveal, however, that this relation exists only for the same type of water and that the amount of chemical used varies greatly from plant to plant even though the turbidity readings are of the same magnitude. Obviously there are other important factors which influence the amount of chemical needed in water purification, such as size and character of suspended particles, alkalinity, chemical composition, etc. The quality of any type of water varies from day to day and from season to season so that the relation between turbidity and chemicals for any single or even a small number of readings may not be clear, but when the readings from a large number of cases are combined the correlation is unmistakable.

In 1937 the total amount of water treated by the 22 Piedmont towns ² which derive their water supply from reservoir sources was approximately 13.5 billion gallons; for the treatment \$68,000 worth of chemicals, or an average of \$5 per million gallons, was used. An estimated average reduction in the cost of chemicals of about \$1.50 per million gallons of water treated can be expected if or when partial erosion control practices comparable to those employed in the High Point, Greensboro, Burlington, and other soil conservation demonstration areas are adopted on all the 22 watersheds. On the basis of the 1937 water use, this would amount to an annual saving of \$20,000.

¹ Project supervisor, division of economic research, Soil Conservation Service, Washington, D. C.

² Data from only 22 of the 28 municipalities were used in the final calculations because information from the remaining 6 municipalities was incomplete in some respects.

Opinions of water supply engineers, water plant superintendents, and other qualified persons indicate that erosion control measures on the watersheds would result in substantially lower operating costs. Some of the factors involved are greater uniformity of raw water with smaller capital outlay for settling basins and for filter plant units, and lower power, labor, and other costs for backwashing filters and flushing or cleaning the settling basins. It is estimated that if the average proportion of suspended matter at the intakes can be decreased 25 to 30 percent, an average reduction in cost of treatment of approximately \$7 per million gallons of water can be expected. On the basis of suspended load sampling, by the United States Geological Survey in cooperation with the Soil Conservation Service at the latter's High Point demonstration project, this is considered a conservative estimate of the effectiveness of changes in land use and application of erosion control measures in reducing the amount of sediment load in the streams. This means a reduction from \$70 to \$63 per million gallons in the cost of finished water at the filter plant. Hence, a total annual saving of approximately \$94,500 for the Piedmont group of towns, not including reduced silting damages to reservoirs, seems probable.

Sedimentation in Reservoirs

The 22 watersheds of the public water supply reservoirs in the Piedmont area comprise a total area of approximately 504,000 acres valued at \$10,900,000 on which buildings worth \$6,000,000 have been constructed, making a total valuation of \$16,900,000 for both land and buildings (U. S. census). For the same 22 cities and towns the total developed storage in reservoirs used primarily for water supply is approximately 36,000 acre-feet. As distinguished from the foregoing primary use, most of these reservoirs have important recreational and scenic values as well, and one, Lake Michie of Durham, is used also for power purposes. No satisfactory practical means of allocating storage capacities needed for different uses are available, and each reservoir must therefore be treated as a composite unit supplying services of several kinds. Their combined original cost is estimated at approximately \$8,000,000, an average of \$220 per acre-foot of storage, including accessories such as pipe lines, pumping equipment and similar necessary items to make the storage available for use. If the accessories are excluded, the average cost is approximately \$5,000,000 or \$134 per acre-foot.

The average annual depletion of aggregate storage capacity through sedimentation is approximately 0.65

percent of the total original capacity and the annual loss of capital value in storage facilities amounts to about \$32,000, not including accessories. Soil erosion control measures are not expected to eliminate all of this annual loss in an agricultural area such as the Piedmont. A certain quantity of sediment will always be present in flood water so long as the land is used for agricultural purposes, and no economical means of avoiding the ultimate filling up of reservoirs from this cause is at present known to engineers and others. The feasibility of greatly reducing the existing rates of depletion has been demonstrated at High Point and is used as a basis for the following computations.

Erosion Control at High Point

The High Point Reservoir was surveyed by the United States Geological Survey in cooperation with the Soil Conservation Service prior to the inauguration of the soil conservation program on its watershed in 1934. At that time the reservoir was 6½ years old. This survey showed an average annual loss of capacity of 0.77 percent.

In the spring of 1938 a second sedimentation survey of the reservoir was made by the sedimentation division of the Soil Conservation Service. During the intervening period of 3¾ years, 39 percent of the total drainage area had been placed under cooperative agreement and the establishment of soil conservation practices, with reorganization of land use, had been completed on nearly all of the farms involved.

The second survey showed that the average annual rate of silting had dropped from 0.77 percent during the first 6½ years of the reservoir's life to 0.59 percent during the succeeding 3¾ years.

The United States Geological Survey in cooperation with the Soil Conservation Service maintains first-class stream gaging stations above the heads of backwater on each of the main tributaries of Deep River leading into High Point Reservoir. A large number of discharge measurements have been made at these stations since the soil conservation demonstration project was established in 1934. Systematic sampling of the suspended load of the streams has been carried on also at these stations since that time. The results show a decrease of about 25 percent in the average amount of suspended sediment in the floodwater. This is true whether based on monthly and yearly averages or on individual storms of approximately the same intensity and duration.

At the old rate of silting, a total of 1,685 acre-feet of storage capacity would have been lost by the time the original excess reservoir storage for water supply pur-

poses became depleted. By that time, i. e., in 1985, a period of 50 years beginning with 1935, the capacity of the reservoir would have been reduced to the point of maximum service demands of the city. During this period an average capital value of \$5,224 would have been lost each year,³ while at the new rate of silting the annual loss of capital value is only \$3,984.⁴

The annual benefit of the present erosion control program to the city is therefore the difference between the annual sediment damage with and without watershed treatment, or \$1,240. In many of the smaller watersheds at least, an even more effective control program should be feasible if the combined town and farm interests adversely affected by the accelerated rate of erosion are included in a consideration of the costs and benefits of its control. The High Point program has been worked out primarily on the basis of agricultural interests of the watershed, and only 39 percent of the land has received some sort of treatment. The percentage of control of the most critical sediment-producing areas such as severely gullied areas, roads, and streambanks, is even smaller. Moreover, the effects of such control practices as planting of trees, the treatment of badly eroded hillsides, etc., will not become substantial until after a considerable lapse of time. Consequently the sustained long-time beneficial effect of the program should become still more pronounced in the future.

³ Original capacity of 4,354 acre-feet $\times 0.77\% = 33.7$ acre-feet per year; 33.7 acre-feet $\times \$155 = \$5,224$ per year.

⁴ Capacity of 4,354 acre-feet $\times 0.59\% = 25.7$ acre-feet per year; 25.7 acre-feet $\times \$155 = \$3,984$ per year.

Conclusions

The 22 reservoir drainage areas constitute, generally speaking, compact problem areas where erosion causes appreciable damage to public water systems and where the general benefits of improved land use can be immediate and real. In view of the large economic losses to the public resulting from sediment-producing erosion, it is apparent that these public costs, as well as the economic losses to individual farms, should be assessed against soil erosion and should be considered in the question of "costs and benefits" of its control. In most watersheds it would seem to be sound economics to control erosion on critical areas of sediment production to a greater degree than the present agricultural interests can justify solely on the basis of protecting the value in the land itself. This is especially true because of the present financial limitations of the farming groups, regardless of the needs of the future. Also, in some of the watersheds, important sources of erosional debris are public highways, where correction must rest with the public.

Whereas, from the standpoint of land conservation alone, widespread upland erosion-control measures may not be justified over some parts of the watersheds and on some types of land, nevertheless when we consider the attendant decreased movement of upland soil particles, with consequent decreased available sediment load and corresponding benefits to downstream developments, a more general adoption of remedial measures becomes justified.

TREE SURVIVAL IN A HIGH PLAINS AREA

By CHARLES G. VAN GORDER¹

WHEN the Dalhart demonstration project was established in the southeast portion of Dallam County, Tex., in 1934, the project technicians faced many obstacles to a satisfactory woodland program for this area. Very little information was available concerning tree planting in this section of the Panhandle. Past experience with plantings was discouraging because of the high mortality rate and farmers over the project area believed that trees could not be grown successfully because of the dry weather. Their many failures seemed to justify this belief. Native trees and shrubs occur only in scattered groups in certain localities along the canyons and intermittent streams. The most common species are the cotton-

wood, willow, hackberry, and western soapberry.

The evidence was that for trees and shrubs to thrive, it was necessary that they have moisture equivalent to 20 to 30 inches of rainfall annually. The average precipitation, however, is approximately 17.50 inches, as recorded over a 30-year period by the United States Dry Land Field Station near Dalhart. The solution seemed to be the accumulation or building up of additional soil moisture and utilizing run-off water in low spots. However, low places did not always occur where trees were most needed. In view of this difficulty, special sites, to which surplus water could be diverted from other locations, were developed by engineering structures.

In the spring of 1935, approximately 12,000 trees were set out on the project. Because the use of accu-

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Two-year-old trees on the Miles farm, after a rain in May 1937. The site was well engineered to hold plenty of field water.

mulated run-off water in growing trees and shrubs was a new practice, it was realized that data concerning survival under such conditions was needed. Especially was information required pertaining to the adaptation of species to the sites. Survival counts, begun in the fall of 1935, have been obtained for the past 5 years. Because of the small number of trees and shrubs in each planting (50 to 500) a complete check of all trees was made to determine survival.

The survival count was made each year in September and October. The percentage of survival for each planting was recorded, as well as the total number of trees and shrubs, alive and dead, of each species on the site.

Table 1 shows the honey locust to be the hardiest and perhaps the best adapted of all the tree species planted on the project. It makes a rapid growth.

There are objections to the many thorns on the honey locust, but observations indicate that the thornless variety is equally as hardy. The osage orange, although drought resistant, makes a rather slow growth. This species deserves wider use in windbreak plantings. The desert willow appears to thrive under dry con-

TABLE 1.—Survival record of tree plantings

Species	Total planted 1935	Number living 1939	Percentage of survival
			Percent
Honey locust (<i>Gleditsia triacanthos</i>).....	3, 807	3, 258	86
Osage orange (<i>Toxylon pomiferum</i>).....	209	173	83
Desert willow (<i>Chilopsis linearis</i>).....	2, 097	1, 711	82
Chinese elm (<i>Ulmus pumila</i>).....	1, 488	1, 129	76
Jujube (<i>Zizyphus jujuba</i>).....	133	99	74
Green ash (<i>Fraxinus p. lanceolata</i>).....	1, 617	1, 178	73
Cottonwood (<i>Populus</i> sp.).....	673	451	67
Russian mulberry (<i>Morus alba</i>).....	1, 868	1, 200	64
Black willow (<i>Salix nigra</i>).....	271	155	57



Enjoying the shade of trees planted by the Soil Conservation Service on farm of W. H. Miles, demonstration project cooperator.

ditions better than any of the other species. It is very desirable for single row windbreaks. It also has a definite place when used as the outside row of a large planting. It produces an abundance of trumpet-like flowers during the last half of summer. The flowers are about 2 inches long, lilac in color with two yellow stripes inside. The desert willow often makes a growth from 3 to 5 feet in a summer. It suffers some frost damage.

The Chinese elm, 10 percent below that of the honey locust in survival, has made an excellent showing. No other tree in Dalhart has been so extensively planted. It is drought resistant, fast growing, and is immune from attack by the red spider, a serious problem with the American elms.

The few seedling jujube trees planted on the project proved to be very satisfactory. The jujube is drought resistant, thrives under limited moisture conditions, is a unique tree in that the short limbs droop and the branches grow in a zig-zag fashion resembling canes of the grapevine. The leaves are of a glossy, dark-green color. The fruit of the jujube is russet in color and about the size of a small olive. It is a highly desirable wildlife tree. Improved varieties produce fruit about the size of a walnut, which, when preserved in syrup, are similar in taste to the date.

The green ash trees have done well where surplus water was available. The ash grows slowly but is highly desirable for use in mixed plantings. This species enters the dormant period early in the fall and consequently escapes frost damage.

No other tree on the project has made as rapid growth as the cottonwood. Many specimens are over 20 feet in height, with trunk diameters of 5 inches. The cottonwood appears to have a shallow root system and will not tolerate an excessively dry or wet location. The large tobacco worm has completely defoliated the cottonwoods on certain sites where no cultivation was practiced.

Survival of the Russian mulberry is low compared with the other species. This tree responds to additional water and cultivation and makes a rapid growth. Under dry conditions, the mulberry appears to be more or less stunted. It suffers some winter injury every year, and when the grasshoppers are serious, they defoliate the trees. The black willow is recommended primarily for use in excessively wet locations, such as the playa lakes. It spreads rapidly by sending up numerous sprouts around the original plant.

Many miscellaneous species have been planted for experimental purposes, but the majority of them gave poor results. In some instances the poor condition of

the planting stock, and the location of the species within the site, undoubtedly had something to do with their failure.

TABLE 2.—Survival record of different types of plantings

Types of plantings	Number of plantations	Total planted, 1935	Percentage of survival
			Percent
Group plantings with engineering structures..	4	1,653	89
Roadside plantings (natural water-level sites)..	36	3,744	86
Roadside plantings with engineering structures.....	14	3,070	84
Farmstead plantings with engineering structures.....	12	2,082	71
Farmstead plantings without engineering structures.....	8	1,614	45

A study of table 2 shows that group plantings, where engineering structures are used, have the highest survival. Roadside plantings, however, are very satisfactory. The natural water level sites are somewhat better than the roadside plantings which required the use of structures, while the farmstead windbreaks had a lower survival. General observations indicate that the greatest amount of growth was made by trees located where natural depressions occurred, and where run-off water accumulated. The trees did well on engineered sites where the structures were properly maintained, and where the trees were cultivated to keep down weed growth. If the engineered sites were neglected, and weeds and sand allowed to accumulate, the sites lost much of their effective water-storage capacity. On the basis of 5 years of experience with tree planting in the Dalhart area, the following conclusions seem warranted:

1. Tree sites should be located either in natural depressions where run-off water accumulates, or on other locations where engineering structures make possible the diversion of water from roads and adjoining fields into the tree planting.
2. Trees should be planted in suitable locations and only by farmers sufficiently interested to care for them.
3. Plantings should be clean cultivated.
4. Trees should be pruned about the base to lessen weed and sand accumulations.
5. Protection against injury by rabbits should be practiced while the trees are small. Wire guards have proved more effective than rabbit repellants.

In the next issue of Soil Conservation: the better-than-fiction story of the Turkey Creek Soil Conservation District. A. E. McClymonds calls his article, "Of the Farmers, By the Farmers, and For the Farmers."

AGRONOMIC INSTRUCTION FOR MODERN AGRICULTURE

By IDE P. TROTTER ¹

EDUCATIONAL institutions long have been regarded as conservative, and agricultural colleges, while less conservative than others, were not completely above criticism in this regard. For years the study of soils and crops was regarded by many as relatively static and much agronomic instruction tended to look backward and emphasize the past more than the future. This seemed to work satisfactorily until about 10 years ago when something began to happen to agriculture along with all the rest of our economy.

To be sure, this something had been accumulating for a long time, but the storm broke about 1930. From the wreckage we gathered together the pieces and began reconstruction. Since the old plan had not worked to everyone's satisfaction, it was decided that agriculture should be rebuilt on a somewhat different plan. New organizations were set up to help chart the course and carry out the plans for a new agriculture. Thus came into being the Soil Conservation Service and the Agricultural Adjustment Administration, to mention only two of those agencies vitally affecting agriculture. These organizations began planning things for agriculture and employed people to operate the plans. They became action agencies. They took the information available in the United States Department of Agriculture and at the agricultural colleges and launched out on a new and unexplored course. People demanded that something be done about the agricultural problems; they wanted the new programs to be tried on a field scale involving whole farms, communities, and even very large watersheds. As a result the Department of Agriculture took on new responsibilities—it became an agricultural planning and action agency for the Federal Government and the cooperating States, whereas previously it had been concerned primarily with education, demonstration and research in agriculture. This new double responsibility for the planning of programs and putting them into use immediately called for men of action with up-to-the-minute training.

For three-quarters of a century the agricultural colleges have been charged with training leaders for agriculture. Those of us responsible for directing this training found suddenly that the change in the

national agricultural program had brought with it a change in the type of training. We were faced with much wider opportunities and larger and more insistent problems. We realized that the opportunity depends on the ability of educational institutions to keep abreast of the rising tempo of planning and action programs. Old courses had to be reoriented and new ones built in order to prepare graduates for the new opportunities and responsibilities that would be incumbent upon them in accepting and holding employment with the action agencies, and also to provide men with the new action viewpoint for the older agencies. We knew that we must all understand this viewpoint and help to develop it along the soundest possible lines.

The problem today is this: How can the agricultural colleges meet the requirements of the most recent action programs? The educational problems involved, and the approach that can be made to them, are particularly difficult in view of the fact that in many instances actual field operations have stepped ahead of the research results on which a sound program must rest. This does not imply that research has lagged; rather, it means that the necessity for immediate application of ideas and measures in an operations program tends to expand more rapidly than scientific and dependable research data can be developed. As a result, many of the present action programs on the land have the peculiar nature of being both operations and research—at least to the extent that trial-and-error methods in the field have played an important part in the evolution of some of the more recently accepted farm practices.

The action programs which have found it most necessary to expand their work into previously unexplored fields are, first, the conservation program and, second, its closely related ally, the land-use planning program. Their training problems and those of the older organizations cooperating with them will illustrate the difficulties encountered and the attempts that are being made toward solution. Our discussion therefore will deal primarily with them.

Administrators of these action agencies discovered very quickly that they not only had the problem of selecting men with suitable training from year to year but that a very large number of their older staff members were in need of new training with the action

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viewpoint in mind. This called for what has been termed "in-service training," which means that men from established professional positions attend agricultural colleges for short periods of intensive special training in line with their types of field work. It became obvious that many of these special courses should be under the direction of competent officials from the action agencies or staff members who have been in touch with the action program—this in order that the latest and most accurate information from the day-to-day developments of these national programs might be presented.

In attempting to discharge its obligations to the people of Texas in connection with the impact of these new ideas and new programs on the State's agriculture, the Agricultural and Mechanical College of Texas inaugurated a series of special courses by visiting professors during the summer session of 1940. The results achieved were sufficiently encouraging to make us believe that we have taken a long step toward meeting the needs of the action programs by furnishing to their workers a valuable yet flexible type of "in-service" training. For the benefit of action agencies and educational institutions, a brief sketch of the courses offered, and a somewhat more detailed description of one which we regard as most typical, is given in the following discussion.

The graduate courses included in the special series, and the men who taught them, were as follows:

Soil Classification and Mapping, E. A. Norton, chief, physical surveys division, Soil Conservation Service, Washington, D. C.

Range Management and Ecology, W. G. McGinnies, chief of range research, Southwestern Forest and Range Experiment Station, Tucson, Ariz.

The Fundamentals of Grass and Pasture Improvement, F. D. Keim, chairman, department of agronomy, University of Nebraska.

Forest Soils, R. F. Chandler, Jr., assistant professor of forest soils, Cornell University (6-weeks course).

Feeding of Farm Animals, F. B. Morrison, head, department of animal husbandry, Cornell University.

Animal Breeding, F. F. McKenzie, assistant professor of animal husbandry, University of Missouri.

With one exception, all of the six special graduate courses offered at the Agricultural and Mechanical College of Texas during the summer of 1940 were conducted over a period of only 3 weeks each; the course in forest soils ran for the customary 6-weeks summer term. The others were so arranged that one was being offered during each of the four 3-week periods constituting our two terms of summer school,

and during only the first 3-week period were two such courses in operation. Thus, it became possible for both graduate students and professional workers to take one or more such courses as their interest indicated and their time permitted. Each course was arranged on such a full schedule that a student carried only the one course of his choice during the 3-weeks period. In this way, it was actually possible to give during the 3 weeks a course as complete or more complete than that of a regular 6-weeks summer term. The 3 semester hours of graduate credit given for each course were therefore fully earned.

Enrollment in the special short-course series reached a total of 152. In addition there were more than a dozen staff members who periodically visited the different courses. Readers of *SOIL CONSERVATION* will be especially interested to know that the course on soil classification and mapping, given by Mr. Norton, was one of the most popular. There was an enrollment of 40 in the class. The students came from 4 States and included 29 Soil Conservation Service employees, 6 vocational agricultural teachers, 1 graduate student, 1 Bureau of Agricultural Economics employee, and 3 undergraduates. Graduates from 20 colleges were represented in the class.

Two advantages of the short-period, intensive type of course should be pointed out. One is that it was possible to secure an outstanding authority in each field to give the different courses, whereas that probably would not have been possible for a 6-week or longer period. From the standpoint of extension workers, Farm Security Administration employees and others actively engaged in agricultural work, many could attend the 3-weeks courses in the time allowed for annual leave, but would not have been able to take time from their regular duties for a longer period of study.

A brief summary of the day's schedule and the organization of work that was followed in all of the classes will probably be of interest.

Each class opened daily at 7:30 a. m. The first hour to an hour-and-a-half was given over to a lecture on the subject at hand by the professor in charge. Following the lecture there was a discussion period that ran as long as the class members desired. These were lively, stimulating periods when every man had the opportunity to ask questions or otherwise "speak his piece." It is to be remembered that the men in each class were there primarily because of their particular interest in the subject matter and the instructor. The majority of them were mature and established professional workers who were using their vacation

time for professional improvement. Needless to say every member was determined to get all that he possibly could out of both the lectures and the discussions. Because of this healthy attitude many of the classes broke up only when the call came for lunch.

Afternoon sessions started at 1:30 p. m., and were given over to practical application of the special subjects. Some classes held afternoon field trips, others engaged in laboratory practice—in short, each class carried into actual practice the subjects that had been taken up in the morning sessions. For instance, members of Mr. Norton's class spent much time in the field, where they studied soils and their classifications, investigated erosion conditions, mapped physical land factors, and made land-use capability maps. In the evenings the entire enrollment of the special course series, together with faculty, extension and experiment station staff members, occasionally gathered to hear lectures by outside authorities in different agricultural fields, or by the specialists who were teaching some of the scheduled courses. More often than not, the undergraduates, graduates, and professional workers carried their discussions far into the night upon returning to the dormitories after the evening meetings.

During two week ends, most of the classes made field trips to different parts of Texas to make first-hand studies in connection with their courses. These 2- to 4-day field trips were high lights of the courses, as they afforded an opportunity for laboratory studies on a large-scale basis under the varying soil and ecological conditions found near College Station. The week-end field trips made by Mr. Norton's class covered nearly a thousand miles. On the first trip the class traveled 450 miles to a southwest area where the soils of a number of physiographic regions might be studied and classified. The second week end took them more than 600 miles through eastern Texas where at least a dozen sharply contrasting soils typical of the humid South were inspected. Short afternoon field trips near the Agricultural and Mechanical College of Texas added some 200 miles, making a total of more than 1,250 miles of travel connected with the course in soil classification and mapping. The three other courses in the agronomic group added about 2,000 additional miles of field travel and study. Twelve hundred more miles represents travel of the four instructors in preparing for class trips.

Only after the close of this extensive series of summer graduate courses was it possible for us to appraise their value objectively. The values turned out to be

so much more vital and extensive than we had anticipated that we believe it worth while to outline a few of them for the readers of the magazine of the Soil Conservation Service. They may be dealt with under four heads: (1) Advantages to the students, (2) to the instructor, (3) to the colleges, and (4) to the profession.

The students indicated that these courses gave them more valuable and flexible courses than had previously been available. To the full-time graduate student came new and practical viewpoints in his chosen field of work, in the classroom and on the field trips, from the visiting professor and from his more experienced associates. The established professional worker who came to take these courses was given the opportunity of keeping abreast of the latest development in his field, both in action programs and at the colleges. He could compare notes from his own experiences with those of his associates in the course who came from many States and many lines of work.

As to the instructor, the courses provided him with the opportunity of visiting and becoming acquainted with a new section of the country, a new group of students and professional workers, and another agricultural college. He also profited in that he was required to organize and present his special information, and to observe the reactions of many men from many places as to its value to them and their sections of the country.

It was not alone the student and the instructor who benefited from the series. Tremendous advantages accrued to the benefit of the Agricultural and Mechanical College of Texas as sponsor of the courses. The special series of courses helped to maintain the college as a center of agricultural education and gave the college staff an opportunity to become better acquainted with other institutions and the action agricultural programs represented by the instructors and the professional men. In general the series aided the educational program by bringing courses up-to-date with the action developments in different fields; men from different colleges, coming together for study in specially selected subjects, helped to renew the spirit of cooperation and understanding among the various institutions represented. We feel sure that the men from different bureaus and agricultural agencies, as well as the college people, profited through the courses by getting down to "brass tack" discussions of their programs and problems, unhampered by office routine—telephones, agency and college regulations, and taboos. We hope that we can include these special courses as a regular feature of our future summer school sessions.

LESPEDeza SERICEA FOR ROAD CUTS AND FILLS

BY VERNE E. DAVISON ¹

HIGHWAYS, including State and Federal roads, constitute a sizable subject for erosion control. The present primary systems in Virginia, North Carolina, and South Carolina cover approximately 9,377, 11,231, and 8,530 miles, respectively. The problem extends also to the secondary roads, about four times the mileage of primary roads. Today these three States have under State or county supervision, in the order as named, approximately 45,734, 58,332, and 43,530 miles, of both primary and secondary roads. This is a total of 147,596 miles, or the equivalent of about six times the circumference of the earth.

While considerable attention is being given to the control of erosion on primary road systems of the several States of the Southeast, much of the vegetative treatment is unsuccessful because the plants being used are not suitable for the conditions. It is reasonable to suppose that the control of highway erosion on secondary or farm-to-market roads will await more practical and less expensive measures than those now used on primary systems.

Lespedeza sericea, a deep-rooted perennial legume, has proved its adaptability to meet many requirements of highway erosion control and related maintenance problems in Virginia, North Carolina, South Carolina, Georgia, Alabama, and Mississippi and is probably satisfactory for parts of Tennessee, Kentucky, West Virginia, Missouri, Arkansas, and Louisiana.

During frequent travels over these and other States, I have observed that the same erosion problems occur over and over again on shoulders, forward slopes, side ditches, fills, back slopes, and above the crown of the cuts. There is a vegetative treatment suitable for each of these conditions.

Before discussing the conditions under which *Lespedeza sericea* is probably the best erosion control plant to use, it may be well to eliminate those wherein its establishment and maintenance would not be particularly desirable. The shoulder, the forward slope of the ditch, and the side ditch itself, present a set of growing conditions quite similar to those of pasture; therefore, a pasture grass, an annual legume, or a mixture of grasses and annual legumes is adaptable and should be maintained in the same manner as is considered best for pasture improvement. The side

ditches adjacent to the road present special problems for which Bermuda grass is excellent because it and other such plants are capable of withstanding large volumes of concentrated flow. Thus, by process of elimination we arrive at the conclusion that for highway erosion control *Lespedeza sericea* probably is more desirable than other adaptable plants for use on (1) the back slope of cuts, (2) steep sides of fills, and (3) borders for cultivated land.

Attention should be given first to the back slope of cuts. Here the exposed subsoils, uncovered by the road cut or drain ditch, require a deep-rooted perennial, as the site is very dry and plant foods are more thinly disseminated than in topsoils. The use of annual lespedezas, Bermuda grass, or other shallow-rooted plants is usually unsuccessful, except temporarily, because sufficient plant food and moisture are not within reach of the roots. Erosion progresses even when topsoil is applied, as there are periods of the year when such plants do not give sufficient protection for steep slopes. To delay the establishment of permanent vegetation is but to double the cost of treatment and to lengthen the period of maintenance. Silt, washing down from the cut, frequently fills up the adjacent drainage channel and is then dispersed on to the road. The deposition must then be removed by hand or maintenance machinery, and this is an operation that is likely to destroy the vegetation which was adequately protecting the shoulder, slope, and ditch before the foreign deposition accumulated.

A second highway site for which this legume is suitable is the steep side of a fill where vegetation requiring a minimum of maintenance is desirable.

L. sericea has been found valuable for planting strips 15 or more feet wide bordering cultivated land. Drainage from crop rows and terrace outlets necessitates construction of small channels above the crown of the cut slope and such channels serve as turn rows for farm machinery. Bermuda grass is frequently used in the channels, but most farmers object to it because the runners may be caught by the plow and released elsewhere in the field.

For the past 5 years *L. sericea* has been used in Soil Conservation Service erosion control demonstrations in the Southeast, for gully control and for field borders. While usually the principal objective was rehabilita-

¹ Chief, regional biology division, Southeastern Region, Soil Conservation Service, Spartanburg, S. C.



Lespedeza sericea provides adequate soil protection for steep banks.

tion of areas for wildlife the conditions were comparable to those encountered in highway protection. Since direct economic returns from wildlife have been relatively small, it has been necessary to reduce expenditure of labor and materials to a minimum consistent with dependability. With this in view, improved methods have been progressively developed, proved, and applied. Road cut or back slope conditions are almost identical with those found on the sloping sides of gullies; the fills are not unlike many field borders on the lower side of sloping cultivated land; and the spread of Bermuda from highway rights-of-way into adjacent cropland is no different from its spread from pasture and terrace outlets. Thus it is gratifying to know that since 1938—in three successive growing seasons—the establishment of *L. sericea* has been demonstrated successfully on highway back slopes, highway fills, and as buffers between Bermuda and cropland.

L. sericea may be established merely by broadcasting scarified seed on well-prepared seedbeds soon after the last killing frost in the spring. The seed should be sown at the rate of 30 pounds per acre, on top of the ground without covering. A moderate application of fertilizer, especially phosphate, is advisable, although the amount should be increased for subsoil conditions. On very acid soils, a little lime will help establish the young plants. No further fertilizing is necessary unless a light green color appears to indicate that the original application was insufficient.

Seeding of *L. sericea* on back-slope subsoils and on

the sides of fills always should be preceded or accompanied by the application of mulch. The plant can be established with mulch on slopes of $1\frac{1}{2}$ to 1 percent. Pine branches applied any time after mid-summer, in preparation for spring seeding, will protect the soil against washing, eliminate hand preparation of the seedbed, and ultimately assure an adequate stand of *L. sericea*. Scarified seed should be sown through the mulch immediately after a rain the following spring. Submoisture is important to carry the young plants through short periods of drought during the first season. An excellent submoisture condition is assured by the increased infiltration and the reduced evaporation resulting from mulch applied in late summer, fall, or early winter. It is usually unnecessary to stake down the mulch, even on steep slopes.

Grain or hay straw may be substituted for pine limbs on moderately sloping cuts and on fills, and usually it is more readily available. Any mulch may be applied at seeding time. *L. sericea* stems are quite satisfactory as a combined mulch and seeding agent if they are cut and applied as soon as the seed is ripe—about the first frost date in the fall. Thus seeding is automatically accomplished with mulching. Most of the scarified seeds do not germinate until spring. An illustrated leaflet,² "Mulching to Establish Vegetation on Eroded Areas of the Southeast," gives full directions concerning mulching materials, their application and usefulness.

Once established, *L. sericea* requires little if any

² Leaflet No. 190, U. S. Department of Agriculture, Washington, D. C.

maintenance for years. An early spring mowing, however, would add to the beauty of the site, as the brown stems of the previous year's growth would thus be hidden by the new green shoots which quickly appear after the last killing frost. Mowing at this time of the year does not alter the permanency of *L. sericea*; however, the stems should not be removed—the ton or more of mulch naturally provided by leaves and stems greatly increases the value of the cover for erosion control. Likewise, to prevent Bermuda grass from spreading, the *L. sericea* should not be cut except just before the growing season when Bermuda is practically dormant. The tall, vigorous *L. sericea*, if uncut, shades out the Bermuda, whereas mowing during the growing season would only encourage the grass as it does in pasture management.

For road cuts that are either too rocky or too steep to be mulched and seeded to *L. sericea*, a vine such as kudzu or honeysuckle is needed.

A few common mistakes in highway erosion-control measures deserve mention. As stated earlier, shallow-rooted perennial grasses and annuals that must reseed are seldom successful on severely eroded sites or where back sloping exposes the subsoil. Grass-and-legume mixtures will not prevent the succession of shrubs and trees unless there is frequent maintenance, and *L. sericea* will not attain a satisfactory stand from such a mixture. Where grasses are wanted, this legume should be left out of the mixture. At one time a mixture of 20 percent *L. sericea* with equal or greater amounts of annual lespedezas and grasses was thought promising where erosion control was the only objective, but it has been definitely determined that annual lespedezas are serious competitors with *L. sericea* and the mixture is therefore not recommended. This point may be summed up by saying, plant *L. sericea* alone or not at all.

A mulch of brush, hay, or grain straw should never be applied without the seeding of permanent vegetation to replace the temporary soil covering. Natural vegetation is seldom of the kinds desired and even frequently fails to become established. A mulch so heavy that seedlings are smothered is to be avoided.

Many kinds of shrubs have been planted on roadside cuts, but very few grow to maturity. In such instances the control of erosion usually is dependent upon scattered weeds and grasses that accidentally catch with the shrubs and provide some ground cover.

The control of highway erosion aids in reducing the silt from running streams—a biological necessity for the reclamation of game fish habitat. Highway con-

tributions of silt, though much less important than the aggregate from farm lands, is worth consideration. *L. sericea* may or may not be of additional benefit to upland wildlife as food and cover along highways, but that is relatively unimportant in this discussion.

The chief disadvantage in using this legume is that it requires 2 or 3 years to provide complete protection, and often it appears to have failed in the first year. No perennial of long life will attain maturity more quickly, however, and the temporary mulch used in its establishment gives satisfactory soil protection until it is replaced by *L. Sericea*. Annual weeds and grasses may seem to choke the young plants the first year; but they will make surprising growth the second year. Clipping the annual weeds and grasses is not advisable.

In summary then, *Lespedeza sericea* is recommended because (1) it is adaptable to a wide variety of severe conditions; (2) it vigorously prevents the encroachment of shrubs and trees and greatly reduces maintenance; (3) it will not spread into cultivated fields or to the shoulders of highways; (4) it is attractive in appearance even without frequent mowing; (5) and it provides continuous living protection to the soil from early spring, through summer, to frost, and an equally effective cover by its dead leaf mulch through winter and early spring.

RANGE UTILIZATION

SOME very significant results of experiments in the utilization of range forage were revealed at the Grassland Conference held at Amarillo, Tex., on September 5 and 6 to discuss grass problems for five Southern Plains States (Texas, New Mexico, Oklahoma, Kansas, and Colorado). This meeting was one of five regional conferences held throughout the United States to study grass—the feeding value of many grass species; their adaptability for various uses; methods of promoting grass growth; means of conserving pastures and ranges for most efficient use.

Comparing income from two range areas of the same size, the first stocked with 1,400 head of cattle and the other with 1,900 head, it was reported that the average income over 22 years was \$6,000 more per year in favor of the area stocked with 1,400 head. On the latter range, the steers and sometimes the heifer calves not needed for replacement were kept to graze the extra grass in years of ample rainfall. In other words, the young stock was kept long enough to determine whether or not there would be feed for them, and, if not, they were sold.

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Compiled by **ETTA G. ROGERS**, Publications Unit



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RED OR NORWAY PINE
Pinus resinosa

A native tree of the Lake States and the Northeast, capable of growing on sandy soils and worn out fields. The red pine is widely used to heal the scars of erosion in regions 1, 3, and 5 where about 4,000,000 or some 25 percent of the total conifers, are planted annually. It is a useful tree to have in any farm woodland, chiefly because of its fuel and lumber value.



FEBRUARY
MARCH 1941

*An Enlarged Issue
Telling the Story
OF
Soil
Conservation
Districts*



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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WELLINGTON BRINK
EDITOR

A FOREWORD TO THIS ISSUE

By the

SECRETARY OF AGRICULTURE

ONE of the most heartening developments in the national war against soil waste is the growing interest in conservation among the rank and file of people on the land. Call it a conservation "philosophy" or "tradition" or whatever you will, it is something this country has not had in the past but must have in the future if we are to be prosperous and secure. It represents a definite break with the exploitive tradition of the American people, which grew up when land resources seemed as inexhaustible as air, and when pressure of a rapidly growing population stimulated us to skim the richest productivity from our lands and forests—and then move on.

The timely growth of a philosophy of conservation and good land use among farmers is of first importance. Without it we cannot hope to win our battle against run-off, erosion, and land abuse. Each of the nearly 7 million farmers on the land must do his share of the conservation job if it is to be done.

Behind much of the increased initiative in soil conservation shown by farmers is the growth of soil conservation districts. The districts are organized by farmers by petition and referendum, are managed by farmers, are operated on a truly democratic basis, and are capable of stimulating the maximum action toward good land use by farmers themselves. The districts are proving to be a logical point of contact between individual farmers and many services from their State and national governments; they provide a much-needed mechanism to apportion the responsibilities of conservation between individual farmers and the community generally.

Within the past 4 years, 38 States have adopted laws enabling the establishment of soil conservation

districts. Four hundred and thirty-five districts, covering more than 271,000,000 acres, have been established in these 38 States. The Soil Conservation Service has been the spearhead of the Department of Agriculture in working with districts, in establishing the basis for cooperation through memoranda of understanding, and in furnishing technical guidance, labor, materials, equipment, and other assistance. At the close of the past year, the Service was extending such aid to 307 districts, covering 186,000,000 acres in 36 States.

However, as the districts movement has grown, it has become apparent that the interests of the Department are not limited to cooperation with them through the Soil Conservation Service alone. Good land use is a goal sought by the Department of Agriculture as a whole. It is a common denominator of many phases of the national farm program. Many agencies of the Department are making contributions that aid districts in achieving this objective. Therefore, in September of 1940, new principles for departmental cooperation with soil conservation districts were issued, providing that the Department would enter into overall agreements with districts, thus establishing a general basis for cooperation. Following this, as any agency of the Department becomes prepared to cooperate with a district, it may enter into a specific supplemental agreement.

The Department constantly is exploring the possibilities of additional cooperation with soil conservation districts. State agencies are doing the same. The outlook is promising. Already many agencies of the Department have found the district to be an effective meeting ground, where they may deal with representatives of farmers who are empowered by the will of the majority to initiate and follow through for better land use over a naturally bounded area.

Claude R. Wickard, Secretary of Agriculture, in his own Indiana corn field.



HERE AND THERE AMONG THE DISTRICTS

For many soil conservation districts throughout the country the State soil conservation committees and district supervisors have found it advantageous to appoint or designate key farmers in communities or neighborhoods within districts to take the leadership in helping the supervisors to carry on the affairs of a district. Such farmers are called *assistant supervisors*; in some cases, *community* or *neighborhood leaders*; in others, *local committeemen*; in a few instances, *group supervisors* as in Arkansas; and, *agents of the State soil conservation committee* in Alabama where they are so designated under the provisions of the soil conservation districts law.

In 1939 the supervisors of the Price River Soil Conservation District, Price, Utah, received many requests for help in eliminating beaver damage along irrigation canals. In the autumn the beavers were trapped cautiously and tenderly; then they were transported to upper watersheds where they built dams and homes unmolested.

Result: Farmers along irrigation canals are pleased. Stockmen in upper watersheds are pleased, because more water is stored there for livestock. The supervisors of the district received no complaints about beaver damage in 1940. The district did all this in cooperation with the Utah State Fish and Game Department.

The supervisors of the Central Alabama Soil Conservation District, the county agent of Autauga County, Soil Conservation Service technicians, the local businessmen and civic clubs of Prattville are cooperating in concentrating their efforts toward the control of erosion on a small watershed above the town. Complete conservation is their aim, and by applying complete farm conservation plans on every farm they may expect to attain their objective. Flood damage is a problem of the farmers and town-folk alike; they are working together to control it by checking erosion. Community interest had to be developed and community action taken. Today, timber protection and fire-control work, as well as other conservation measures, are being undertaken on a neighborhood basis. The need for planting stock to establish sufficient thick-growing vegetation (principally kudzu) was a problem—the supervisors, with the help of cooperating agencies and individuals, are now establishing a district nursery.

Green Crowley Ridge Soil Conservation District in Arkansas has a community work execution plan for that part of the district in which C. C. C. labor is being used. Local leaders arrange for meetings to outline work for a 10-work-day period; a representative of the C. C. C. camp attends and lists the jobs the cooperating farmers are ready to start. All of the C. C. C. enrollees (two crews), with one foreman, are then assigned to this community while the other foreman attends another such meeting and outlines work for the following work period. To be eligible for work during a period the farmer must either attend the meeting, send a representative, or send word by a neighbor stating the work he expects to do.

The supervisors of the Cedar Soil Conservation District in North Dakota have worked out leasing arrangements, with State and county land administering agencies, that permit the district to make necessary land allotments to ranchers within the district. Under the plan, sizes of units are adjusted to provide for conservation and good land use, with adequate operating scope. The district also has enacted ordinances restricting the use of grazing lands to sound conservation and ranching practices. It is thought that with this cooperative program together with range conditions, water supplies, and feed reserves as developed in the district, some measure of permanency can be expected for the agriculture of the area.

One district cooperator in the Tallahatchie River District of north Mississippi has found a new and perhaps unique argument for the use of crop rotations in that area. He reports that on large farms with several tenants if a good rotation is followed all the crops in the rotation may be put in one field near the tenant's home, thus facilitating cultural operations carried on by the tenant. In the old method of cropping, the different crops in a rotation such as corn cotton, grain, and lespedeza were scattered over the entire farm, and tenants were compelled to travel considerable distances to and from fields while carrying on their farm operations. We now have a new and sound argument for the use of good crop rotations in strips for large farms in the Southeast where the farms are operated by several tenants.

SOIL CONSERVATION



CLAUDE R. WICKARD
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

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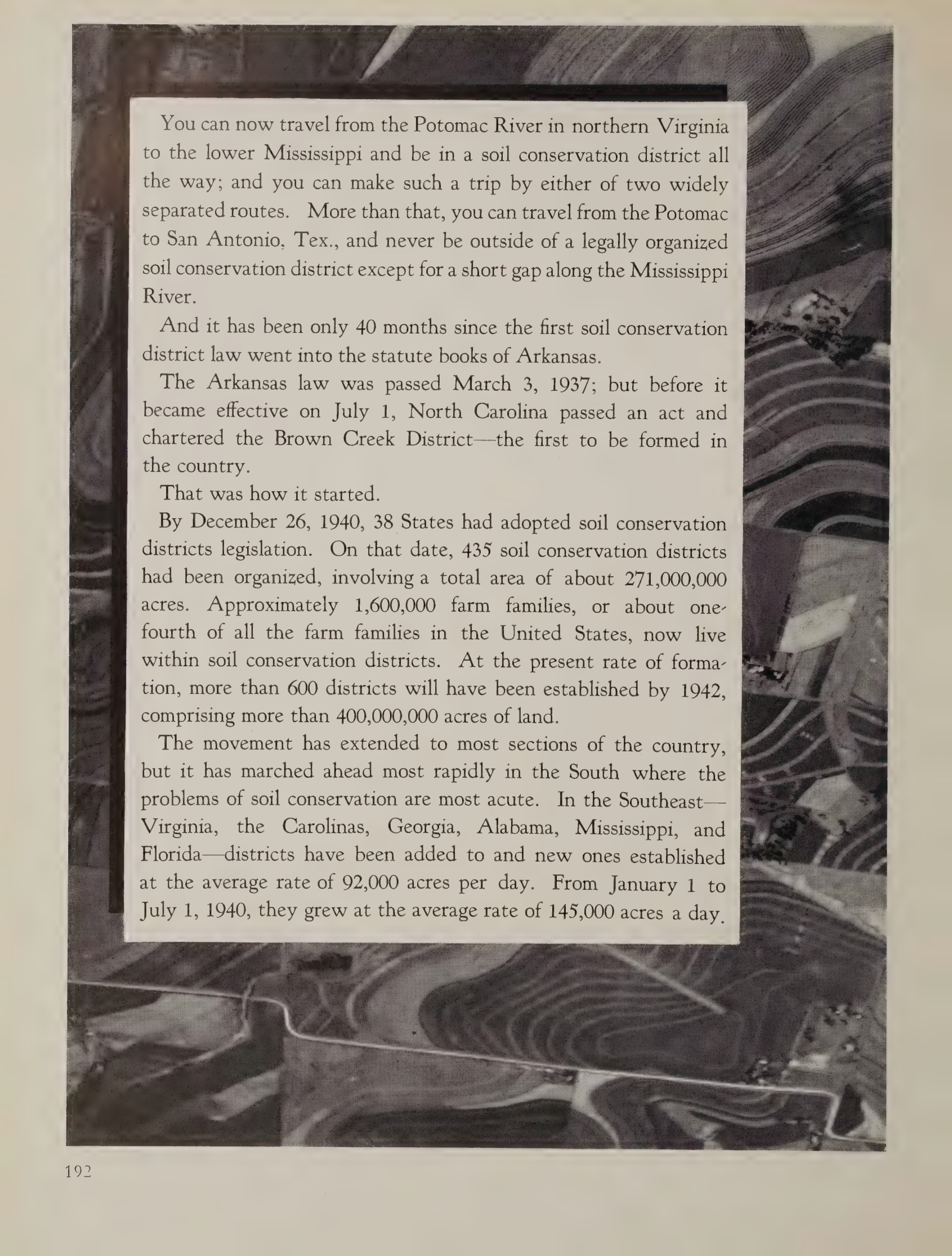
A NEW FARM MOVEMENT TAKES RAPID ROOT



BY H. H. BENNETT, CHIEF,
SOIL CONSERVATION SERVICE

In this introductory article, Dr. Bennett finds in decentralized activity—farmer control—the key to permanent and effective soil conservation districts

THE soil conservation districts movement is sweeping this country in a manner unprecedented in our agricultural history. There have been important movements among farm people in education, social betterment, cooperative marketing, health protection, livestock and crop improvement, and other fields. But there has been no movement comparable in speed, scope, or significance to the spread of soil conservation districts formed by landowners themselves for the defense of their own lands through their own leadership and direction.

An aerial photograph of a terraced hillside, likely for agricultural or conservation purposes. A winding road or path is visible on the left side of the image, cutting through the terraced fields. The terrain is rugged, and the terracing is clearly visible as a series of curved lines following the contours of the hill.

You can now travel from the Potomac River in northern Virginia to the lower Mississippi and be in a soil conservation district all the way; and you can make such a trip by either of two widely separated routes. More than that, you can travel from the Potomac to San Antonio, Tex., and never be outside of a legally organized soil conservation district except for a short gap along the Mississippi River.

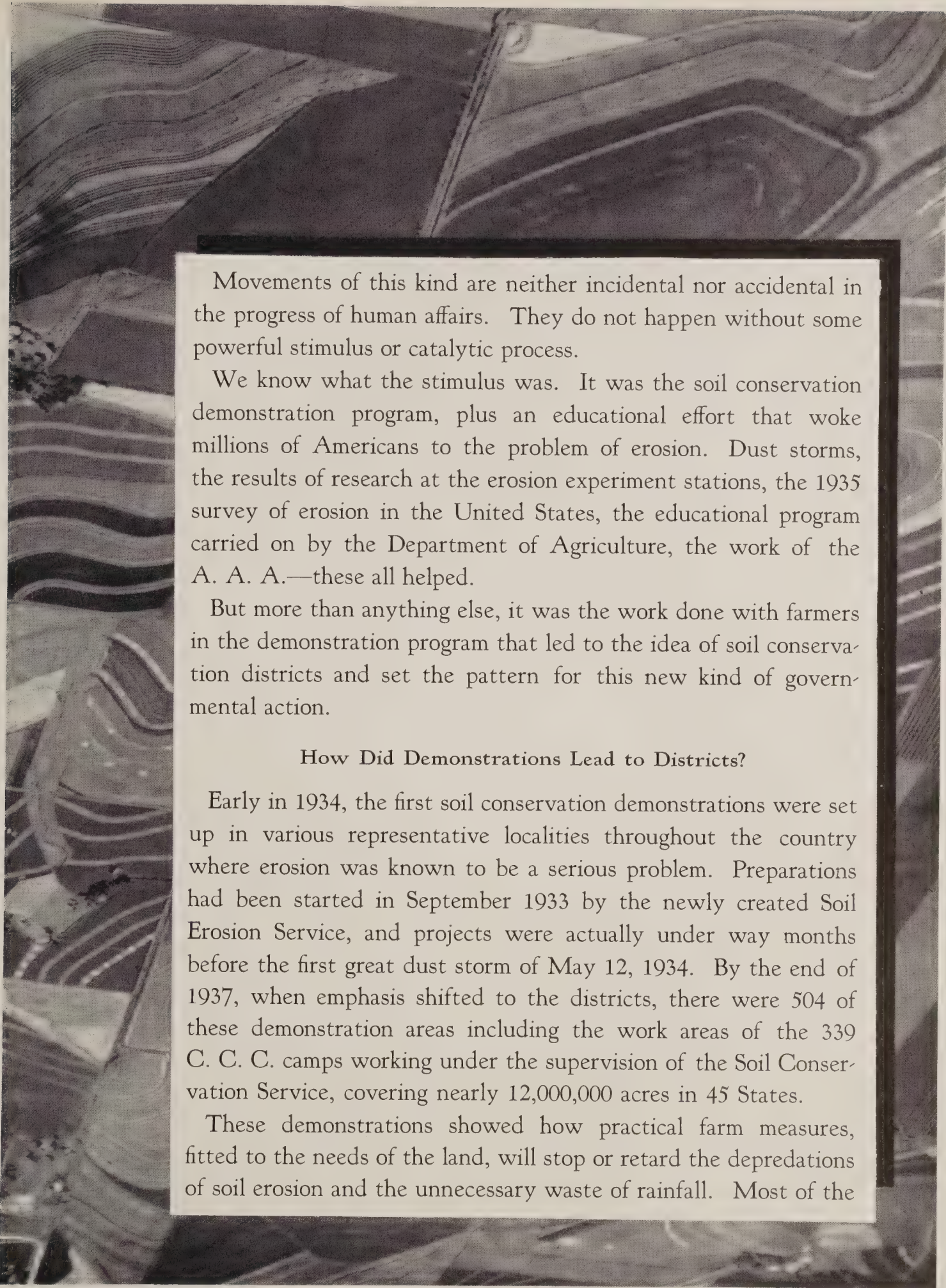
And it has been only 40 months since the first soil conservation district law went into the statute books of Arkansas.

The Arkansas law was passed March 3, 1937; but before it became effective on July 1, North Carolina passed an act and chartered the Brown Creek District—the first to be formed in the country.

That was how it started.

By December 26, 1940, 38 States had adopted soil conservation districts legislation. On that date, 435 soil conservation districts had been organized, involving a total area of about 271,000,000 acres. Approximately 1,600,000 farm families, or about one-fourth of all the farm families in the United States, now live within soil conservation districts. At the present rate of formation, more than 600 districts will have been established by 1942, comprising more than 400,000,000 acres of land.

The movement has extended to most sections of the country, but it has marched ahead most rapidly in the South where the problems of soil conservation are most acute. In the Southeast—Virginia, the Carolinas, Georgia, Alabama, Mississippi, and Florida—districts have been added to and new ones established at the average rate of 92,000 acres per day. From January 1 to July 1, 1940, they grew at the average rate of 145,000 acres a day.



Movements of this kind are neither incidental nor accidental in the progress of human affairs. They do not happen without some powerful stimulus or catalytic process.

We know what the stimulus was. It was the soil conservation demonstration program, plus an educational effort that woke millions of Americans to the problem of erosion. Dust storms, the results of research at the erosion experiment stations, the 1935 survey of erosion in the United States, the educational program carried on by the Department of Agriculture, the work of the A. A. A.—these all helped.

But more than anything else, it was the work done with farmers in the demonstration program that led to the idea of soil conservation districts and set the pattern for this new kind of governmental action.

How Did Demonstrations Lead to Districts?

Early in 1934, the first soil conservation demonstrations were set up in various representative localities throughout the country where erosion was known to be a serious problem. Preparations had been started in September 1933 by the newly created Soil Erosion Service, and projects were actually under way months before the first great dust storm of May 12, 1934. By the end of 1937, when emphasis shifted to the districts, there were 504 of these demonstration areas including the work areas of the 339 C. C. C. camps working under the supervision of the Soil Conservation Service, covering nearly 12,000,000 acres in 45 States.

These demonstrations showed how practical farm measures, fitted to the needs of the land, will stop or retard the depredations of soil erosion and the unnecessary waste of rainfall. Most of the

areas took in the whole drainage basin of one or more typical streams—all the land extending back from the stream banks across fields, pastures, and woodlands, to the upper limits of the smallest streams, and to the top of the enclosing uplands.

On the farms within these areas, control work was carried on in close cooperation with those farmers who could see their way to enter wholeheartedly into a complete program under which every acre of their land would be treated in the most effective way from the standpoint of saving soil and maintaining or increasing income.

The results generally were successful to a considerable degree, in numerous instances to a very high degree. Some measures failed to do the job they were intended to do. Those were discarded immediately and others were tried—better measures frequently were indicated by those that had failed.

Not only was erosion reduced or completely controlled, but flood heights were markedly reduced along many small streams, and some streams that had been running red or yellow or brown with flood flows charged with rich topsoil were reduced in turbidity or almost cleared up. Many actual examples could be cited.

The success of these demonstrations was immediate. As interest in them grew, farmers began to demand more and more assistance in controlling erosion, conserving water, developing wildlife, draining wet lands, controlling floods. Since the beginning of this demand in 1935, there has been no let-up for a single moment. Every day since the results began to show, 6½ years ago, the demand for more assistance in soil conservation and related work on the land has increased. It has poured in on the Soil Conservation Service and other agencies, both Federal and State. It keeps on coming, from the people who live on the land.

It was this farmer demand, usually strengthened by the voice of the entire community—the townspeople as well as the farmer—that led to the development of the soil conservation district movement. The experience gained through the soil conservation demonstration projects pointed to the need for increased community action in soil and water conservation, for greater assistance and wholehearted participation on the part of all the people affected by the impoverishment and ruin of productive soil. The results of the demonstration work showed also that we had reached the point where the main job was not merely to show what could be done, but to spread as rapidly as possible those measures of conservation that would give security to the agricultural land of the Nation.

This was a work task of immense proportions, involv-

ing the protection of hundreds of millions of acres of farm land, grazing land, forest land, and land for the sustenance of wildlife. Surveys showed that of the 462 million acres, approximately, of *good farm land* remaining in the country (including that currently in use and that which could be brought into use through irrigation and drainage operations), all but about 130 million acres was subject to erosion wherever used without adequate measures of protection. Good land was washing or blowing away at the rate of more than 500,000 acres every year, with a vastly greater area undergoing continuing impoverishment.

Abuse of land goes beyond the field, beyond the farmer. It touches the entire community, the whole Nation. Waste the farmer's capital of productive soil, and you squander the support of villages, towns, and cities. Migrant farmers, underfed Americans, choked streams and floods mounting to higher crests; reservoirs ruined by the products of erosion, drainage canals and ditches filled, highways, railways, and bridges washed out or undermined, bleak gullies and sterile subsoil for vanishing wildlife—these and other symptoms of national decline are results of erosion that reach beyond the fence lines of fields.

To cope on a broad scale with this problem of a vanishing land resource and all its allied evils, the soil conservation district was designed and proposed.

What Are Soil Conservation Districts?

Soil conservation districts are farmer-formed and farmer-run, for farmers. They are established only upon the petition of landowners and then not until the will of the majority has been expressed in a refer-

The value of supervisors or groups of district farms pooling their resources for the purchase of special harvesting equipment is being demonstrated in the Tallahatchie River District of Mississippi. In this district, a group of farmers has purchased a tractor and combine to harvest seed for farmers on a share basis. By taking part of the seed as a charge for the harvesting service, it has been possible for the purchasers of the equipment to pay for it in a relatively short time. Not only is this a good practice because it gets seed harvested at a low cost, but it encourages more farmers to plant for seed production, thereby assuring a good supply of the kinds of seed required in carrying out conservation plans for their respective farms. This practice of farmers buying equipment by pooling their resources is being encouraged by all agencies cooperating with soil conservation districts.

endum. The districts are controlled and operated by a board of five supervisors, three of whom are elected by the farmers. Every landowner has a voice in shaping the policies of the district in which he lives. The vote of the one-horse farmer is just as strong as that of the large-scale operator. The aims of the district, its land-use policies, and the soil and moisture conservation measures it recommends, are set forth in a work plan, which is drawn up by the local supervisors and approved or disapproved by the landowners.

The districts are legally constituted units of local government set up under a State law. They are a new kind of government organization. They owe no allegiance to any State or Federal bureau or agency, or to any local organization. They have no taxing power. The operating procedure represents democracy at its best. Not a step is taken, not a plan is made, not an erosion-control measure is placed upon the land that does not first have the concurrence of a majority of the landowners affected.

In carrying out the work of conservation within a district, the farmer-controlled board of supervisors may call upon local, State, and Federal agencies for such assistance—technical and otherwise—as the agency may be in a position to provide. At present the Department of Agriculture is cooperating with 294 soil conservation districts throughout the country.

In many of the districts now operating, business, professional, and agricultural interests have allied themselves in a manner seldom duplicated in any other type of community activity. The districts are not merely erosion-control agencies. They may, by law, perform any function which contributes to the "conservation of soil and soil resources"—and that just about runs the whole scale of land-use operations.

For example, one southern district operates a nursery where seedlings are produced for planting on co-operators' farms. Labor for these nurseries is provided by local farm clubs and community organizations in a way that resembles the old log rollings, house raisings, and quilting parties of pioneer days. Districts in some localities are operating marl pits for the production of marl for improving pastures and fields. Some districts are providing machinery for crushing limestone, while the C. C. C. and W. P. A. provide labor. Many districts deal with flood-control problems, and several have established fire-protection associations.

The Winooski Soil Conservation District in Vermont is concerned largely with streambank erosion control. The San Mateo District of California is attempting to improve irrigation practices as part of its program. The Cedar District in North Dakota is leasing certain

THE FRONT COVER

Drawn by C. E. Margraff

Continuing our series of drawings of plants useful in soil conservation, our front cover this month depicts *Eucalyptus globulus*, or blue gum, a native of Australia and the Malayan Peninsula.

Now a naturalized Californian, *Eucalyptus*—some 60 species—has been planted for windbreaks, street shade, ornamentals and timber. The tree is chiefly valuable because of its adaptability to dry sites and eroded slopes.

Farmers have been encouraged by the Soil Conservation Service to plant *Eucalyptus* for erosion control and for fuel. One hundred cords per acre have been produced in 35 years, proportionately large volumes in 10 to 15 years. One hundred thousand trees of four species is the annual output of Soil Conservation Service nurseries in California. These trees leave the nurseries in paper pots, one to a container, assembled in "flats" for convenient handling. The useful range of *Eucalyptus* is limited because it cannot safely be planted where temperatures fall below 20° Fahrenheit.—The Editor.

county and State school grazing lands, then subleasing on a restricted grazing basis in order to improve the range. The Leake District in Mississippi is attempting to drain the more level lands so as to be able to retire to trees the steeper slopes now being farmed. The control of floods, the purchase and retirement of submarginal lands from the hopeless kind of farming that perpetrates relief problems, adjustment in the size of farm and ranch units, more equitable methods of taxing the land, the development of water facilities such as stock-watering ponds and wells, farm forestry, improvement of land-tenure conditions, and numerous other undertakings are among the objectives of many of the soil conservation districts across the country. Practically all districts are attempting to bring about the best possible use of each acre of land and at the same time to conserve and rebuild it so that the men, women, and children on the land may live decently, securely, and happily.

There is in the district probably the most potent stimulus to maintenance of conservation habits and conservation works—in short, the best possible instrument ever devised for the establishment of permanent agriculture through the building of a conservation culture.

In many districts farmers are receiving the assistance of the W. P. A. in fighting erosion. These projects are locally sponsored by the districts themselves.

A sound district program and work plan are the first essentials in a successful district enterprise. Success in any soil and water conservation work will depend, always, upon clear understanding of the landscape—not just what farmers know, but on this plus what the land technician, the erosion scientist, the plant specialist and other technicians know individually and collectively. And not only that—it is necessary to have also the collective application of this technical and practical knowledge, fitted to the land according to the adaptability of the different kinds of land and the individual needs of every acre of land in every field, woodlot, pasture, of every gully and every flooding streamlet. Furthermore, one measure should be used to support another, and what is done in one field should be done, wherever possible, so as to benefit an adjacent field or gully or some piece of land somewhere downstream.

Sound district achievement, like most other types of enterprises, requires a force that has sufficient technical skill to meet whatever problems arise within the enterprise. At the present stage of development, soil conservation districts are necessarily relying largely on public agencies, particularly the Soil Conservation Service for this skilled technical help. The districts should look forward, from the very beginning, to the day when farmers and ranchers themselves will have acquired more of the skills which they may now lack, but which are necessary to carry out the district program—skills that will become conservation habits.

With all the assistance they can get, district supervisors face a huge task. It is similar to the task now confronting the airplane manufacturers of this country—namely, applying mass production methods to a product that in the past has been made on the basis of one unit completed at a time. The single-unit processes of manufacture are being adjusted to assembly production. As a result, rate of manufacture is being speeded many-fold. The principle of mass production is being approached in many districts. Small groups of land operators meet with a conservation technician to prepare collectively, so far as possible, for conservation operations in their neighborhood. Of course, it isn't so simple to plan farms for conservation action on a mass production basis, because each farm is different from every other farm as to physical land characteristics, financial condition, managerial ability of the operator, and many other factors. Nevertheless, several techniques usually are applicable to all the farms of a given locality, so that these can be explained to groups rather than to one operator at a time.

A map for each farm showing a classification of land

according to use capabilities helps to make such planning possible. A table of recommendations as to cropping systems and supporting conservation practices for each class of land developed by supervisors, representative farmers, and technical men is a further aid. These plans, of course, cannot be completed in the group. They must be checked and completed by actual observation on each farm by the technician and the land operator.

Districts Function "At Grass-Roots Level"

Recently much has been said about decentralization of the work of agricultural agencies and the turning over of agricultural programs to county, State, and other organizations.

Through the soil conservation district, the Soil Conservation Service has decentralized its activities to the ultimate degree. Its operations are guided by farmers themselves, through the functioning of democratic processes at the grass-root level. It may be said that through this approach, the responsibility of soil and water conservation work is actually in the hands of farmers themselves. And the work of conservation is going ahead in this way very well.

In fact rather than in theory, the Soil Conservation Service has decentralized its major activity in a way that farmers understand and approve every day through local community action on thousands of farms throughout the country.

With the increasing demand for kudzu planting stock in many of the districts of the southeast, occurs a new development which may lead to a considerable increase in the domestic supply of kudzu seed. At Dadeville, Ala., a plan has been initiated whereby farmers and their families will collect kudzu seed from local plantings and sell this seed to local merchants at the present market price for kudzu seed. This will not only assist in meeting the demands for kudzu planting stock but will provide an income for farm families. The value of this plan should grow as the amount of available seed from kudzu plantings increases.

In the Huntington River Soil Conservation District of central Utah east of the Wasatch Mountains, depositions of sediment from the flood flows of mountain streams with seedings of reed canary grass, strawberry clover, and timothy are being used to restore alkali lands, formerly abandoned to saltgrass and alkali weeds.

DISTRICT OPERATION FROM A SUPERVISOR'S STANDPOINT

BY F. S. HURD ¹

HERE in what is now the Arkansas-Verdigris Soil Conservation District we recognized the need of a farm program long before the State passed a soil conservation law. We had watched the once bountiful crops grow less in quantity and poor in quality with the attendant privation to our people. We were alarmed at the slow calamity moving in on us because of loss of fertility from our farms.

In 1934 we learned that a sub-Civilian Conservation Corps camp located at Keystone, Okla., was to be moved, and we made an effort to get it moved to Broken Arrow. Our Broken Arrow Chamber of Commerce spent more than \$1,200 in remodeling store buildings and warehouse space for this camp.

Our people saw that the 10-point program of the Soil Conservation Service was good and an answer to our farm problem. As a result of the C. C. C. demonstration work, at the first meeting of the board of supervisors as a directing body we found lying on our desk over 200 requests from farmers for district aid.

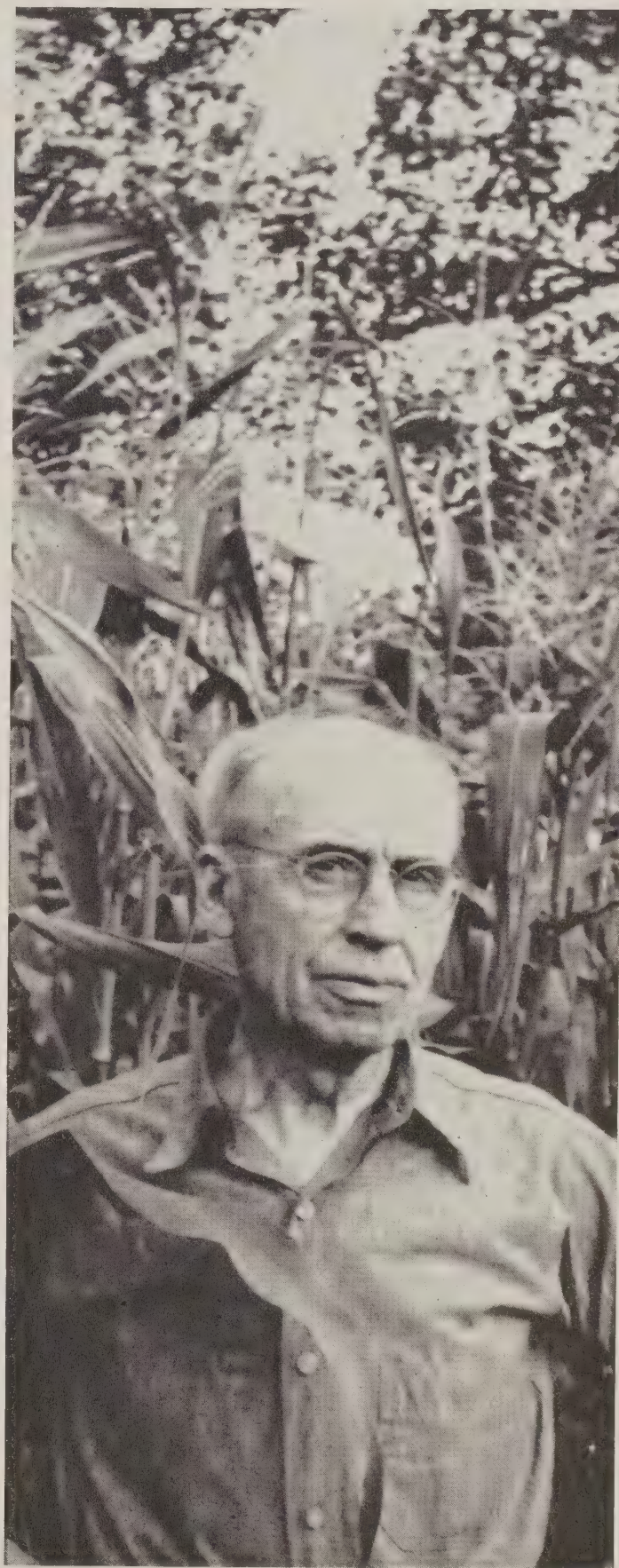
Every member of the board was active in behalf of the organization of the district. They attended meetings, received applications, visited demonstration projects, and participated in tours through areas where C. C. C. camps were doing soil conservation work. All approved thoroughly of the program. The personnel constituting the board gives a splendid cross-section of the district. The membership of the board was and still is: C. W. Wolcott, realtor; J. W. Henderson, dairyman; Herbert Moody, merchant; Ben Phenix, farmer; and F. S. Hurd, banker. All members own and operate farms.

All-Out Soil Defense

In motivating the district program we called into our supervisors meeting representatives of all agencies that we thought could render us assistance, in order that they could plan with us and advise us along the lines of their training and experience. We have continued this policy; at every supervisors meeting representatives from some agency have met and planned with us, so that the district has many agencies to thank for their splendid support, valuable contributions and suggestions.

The board of supervisors has called upon the State Soil Conservation Committee for assistance and they

¹Chairman, Board of Supervisors, Arkansas-Verdigris Soil Conservation District, Broken Arrow, Okla.



F. S. Hurd.

have always responded nobly in getting for us everything that we could use for the benefit of the district. Their cooperation has been a wonderful help in carrying out the program.

The first official meeting held following the beginning of the district operations, October 16, 1938, was one never to be forgotten by members of the Board. We had invited representatives of the Soil Conservation Service. The technicians of that Service who had been assigned to assist the district were present, the State coordinator of the Service, the superintendent of the C. C. C. camp, three county farm agents, several teachers of vocational agriculture and representatives of several other agencies—all were present. This was a very profitable meeting. We knew we were pioneering and wanted to make as few mistakes as possible. Many valuable suggestions were received. There seemed to be unanimity of opinion that we should get the program on the land as quickly as possible. One look at the large number of applications led the board to decide to give priority of application to the farmer who had his "team hooked up and ready to go." This was one of the most important decisions of our board during the 2 years that this district has been in operation.

Supervisors Set Example on Own Farms

The district supervisors made another very important decision at this first meeting—that every member of the board sign a farmer-district agreement just as soon as the district technicians could make the necessary plans. By working out an agreement on our own farms we were in much better position to understand all phases of this new but very important action program. This second decision has proved its value many, many times during the past 2 years.

Education Leads the Way

The first 3 weeks of district operation consisted almost entirely of preliminary work, holding meetings, developing *land-use capability charts*, and other work which was considered necessary before farm planning could be done successfully. The supervisors accepted the responsibility of seeing that copies of the work program and plan were given wide distribution especially among schools, teachers of vocational agriculture, bankers, and leaders of rural organizations. They cooperated with many agencies in sponsoring and holding meetings, tours, and demonstrations. In fact, the records show that during the first 20 months of operation, 98 meetings were held, 17 farm tours were conducted, and 64 articles appeared in the various newspapers covering the district.

We have been constantly confronted with a number of interrelated problems in our over-all agricultural planning for a unified attack on the local problems of our district. In coordinating the work of the various agencies we use a common-sense land-use planning, always taking into consideration that our farmers must make a living while they are saving and building up the land.

As supervisors, we would first call attention to the need for a consistent and far-reaching educational program. This program is one in which there must be no let-up. It must lead the way consistently month after month, and year after year. The district supervisors have made it a policy to cooperate in sponsoring district-wide meetings each year to which cooperators, farmers, and representatives of other organizations can come to obtain a vision, get an inspiration, and receive information that will help them do a better job of conservation. Such meetings not only are helpful to our own farmers, but have a very wholesome effect upon representatives of other organizations attending the meetings. We have a pasture program meeting in the spring in which all farmers are asked to participate, and the benefits derived from soil conservation on farms of cooperators are viewed and discussed. Also, a fall program meeting, participated in by our farmers, is held to encourage protection of wildlife and suppression of fires on the farms.

The Butcher, the Baker, the . . .

A review of the program for one such meeting called for the purpose of promoting wildlife improvement and fire-prevention activities within the district, shows the agencies and their representatives who were on the program: A district agent of the Extension Service; the assistant State supervisor of vocational agriculture; an extension conservationist; the former chairman of the Oklahoma Fish and Game Commission; a forest ranger and a game ranger; the manager of an erosion experiment station; the county superintendent of schools; the superintendent of a C. C. C. camp; a regional biologist of the Soil Conservation Service; the head of the entomology department of the Oklahoma Agricultural and Mechanical College; the chairman of a board of supervisors; and the secretary of the Oklahoma Banker's Association. The results of this meeting have been very gratifying. Wildlife improvement and fire prevention campaigns were conducted in a dozen counties and in several soil conservation districts as a direct result of this meeting.

In our district educational campaign, 3,305 people were in attendance at 18 meetings held in November



Approximately 10 tons of forage per acre was the yield of grain sorghum grown here in erosion-resistant strips and shocked on the contour.

1940. The C. C. C., the Extension Service, and schools cooperated with the board of supervisors in holding these meetings.

The Arkansas-Verdigris Fire Suppression Association, a voluntary association with a membership of 4,000 persons, was the outgrowth of an educational meeting held in the fall of 1939. The pre-suppression fire work of this association has done much to make the people of the district "fire-conscious."

Public Acknowledgment

We are making a policy of giving credit where credit is due. If a cooperator has done a splendid piece of work we believe in telling him and asking his permission to publicize what he has done. The newspapers of the district have done a marvelously cooperative job in helping to extol the virtues of the program and tell what has been accomplished by the individual farmer on his own farm. Recently we have started another program which we believe will go a long way toward improving the programs being established on the farms: Station KTUL at Tulsa, Okla., is giving a radio salute each morning on its farm program. This salute lasts about 4 minutes and gives the name of some cooperator—whether he is owner, tenant, or operator, where he is farming, what he has done (the practices established), and what have been the results. *In other words it is a testimonial of some farmer who has found to his own satisfaction that the establishment*

of conservation practices on his own farm is a paying proposition. This is one way by which we recognize a cooperator when he has done a good job just a little better than it is usually done. We believe it will promote and improve the quality of the program we are establishing on the farms.

The district supervisors always have shown a keen interest in preparation and sponsoring of exhibits and displays at the community, county and State fairs. These exhibits have done much to acquaint the people with all phases of the program and we have found that they provide another opportunity for recognizing outstanding accomplishments. We never miss an opportunity to supply speakers for civic clubs, short courses, and other meetings where people want to learn of the district program. The members of the board have shown a deep interest, are regular in their attendance at supervisory meetings, on time, and usually have a definite contribution to make for betterment of the district. Many special meetings have been called and we have always had a quorum.

Tulsa, a city of 150,000 in population, is located within this district, and Muskogee, a city of 32,000, is adjacent to the district. We have found that the nonfarm owners in these two cities, and in the towns of our district, are interested in soil conservation. Through local chambers of commerce, garden clubs, and other civic and social organizations, as the non-farm owner gains an understanding of the problem and

gives us his support, *we are establishing mental projects in soil conservation.*

The Extension Service has been a main source of supply in this educational program but we have called on many other agencies for special material and help.

Flood Control by Soil Conservation

Flood control and silting of streams are among our district problems. In the short time that the district has been in operation we have had ample demonstration from farms under our program that we can keep the raindrop where it falls. One among many instances is the W. A. Vandever farm just south of Broken Arrow on which a complete soil and water-conservation program has been established. From a 4-inch torrential downpour not one drop of water left the Vandever farm. The little streams that border the soil-conservation farms now carry a minimum of run-off water and give a promise of flood control along our larger streams, with a cessation of silting of streambeds and of huge, expensive reservoirs.

One serious problem which we encountered in beginning our supervisory work was the large yearly shifting tenant population in our district. We are finding that this conservation program slows down the movement of the tenant from one farm to another. Where landlord and tenant sit down together and work out a 5-year program of soil improvement by crop rotation from one field to another, consider the needs of the farm and how to meet them—with the agreement signed by tenant and landlord and approved by the district supervisors before them, with district technicians visiting that farm frequently to see that the agreement is carried out—with all these definite advantages a new interest in the whole district plan springs into being in the minds of both landlord and tenant. With a vision of the 5-year program ahead, both landlord and tenant begin to feel more permanently settled and look with a new and unified enthusiasm upon the problems of their particular farm.

Giving the Farmer a Lift

The district supervisors have tried not to overlook any opportunity to further the district program. C. C. C. assistance was available from the beginning; however, we were very "stingy" with labor and agreed to limit it to approximately one man-day per acre. Past events have shown that this was a wise decision. We now have two W. P. A. work units assisting the farmers in the establishment of conservation practices. On an average, 80 men are employed on these two projects. The work done through W. P. A. assistance has been highly satisfactory.

Arousing Inventive Genius of Farmer

As supervisors, we have endeavored to impress upon the cooperator that it was his duty to do the work and that he should not feel slighted if very little labor assistance was given him. We have tried to show the farmers how they can improve their methods and increase their efficiency so that they can accomplish a great deal with very little assistance from the district. It was in keeping with this policy that the supervisors sponsored a Bermuda Grass Planting Demonstration last spring, using home-made planters. This demonstration was an outstanding success. More than 200 farmers and other interested persons attended. *The results were that more than 20 different kinds of farmer-made Bermuda grass planters were built by the farmers.* All the labor assistance that the district was able to give for a 2-month period was used in harvesting and hauling Bermuda roots, while the cooperating farmers did the planting themselves.

Another important matter that we have been pushing as supervisors is roadside improvement. A properly sloped, vegetated roadside controls roadside erosion, lessens the expense of road upkeep and makes for less traffic hazards. Now that a large national defense program is under way, the supply roads from our farms to the arterial highways of our Nation should receive our earnest consideration. In connection with roadside improvement we are studying the problem of establishing roadside parks and beautifying the roadside.

Wildlife in Strip Pits

One of the many small problems that we have under advisement is some means of utilizing the ugly eyesores in our scenery caused by strip-pits from which coal has been taken. When the farm program is well under way we hope by forestation to utilize these pits as wildlife refuges so they will become spots of beauty to the eye and a source of joy to the sportsmen.

At the present we are working on ways and means of getting our educational program to the absentee landlord. A land ownership map is being prepared for our use and it will be of material help; but we are aware of the fact that an educational program for the absentee will of necessity be quite different from the programs we have sponsored for our resident people.

The unanimity and accord which we have had on the part of our cooperators bespeak the value of the continuous educational program and the follow-up work done by our technicians.

The district supervisors believe in dividing up their responsibilities and work among other agencies—



Each farm under agreement for erosion control is planning either a post lot or windbreak belt of trees. Pictured here is a portion of a 3-acre plot on the G. L. Hollabaugh farm 3 miles west of Broken Arrow. Catalpas—they were set out in 1939. After being girdled by rabbits, sprouts came along and made an astonishing growth. The lad standing here is 6 feet 2 inches tall.

seeking their cooperation and assistance. We believe that we attained a most important goal when we secured the cooperation of seven teachers of vocational agriculture in the district. Each instructor has been given copies of every farmer-district agreement written within his school district. These are assigned to members of his class, while the supervisors work with the teacher, and farmer and student attempt to make the work as profitable as possible. The student studies the agreement carefully, visits the farmer, talks over the entire program of conservation and farm management with him. The boy makes a report from time to time to the teacher and the supervisors on the progress being made in the establishment of practices and completion of obligations as set forth in

the agreement. The farmer is really an assistant to the vocational teacher, giving practical demonstration to the student of how the district program works on his particular farm.

Leadership, decision, and administration are the responsibilities of the supervisors. Receiving no remuneration for our services, influenced by no body politic or otherwise, we work for the betterment of our immediate farm community as it takes its place with other communities for the State and national welfare.

Conservation Moves Over the Land

We think we have made considerable progress since October 16, 1938. The first cooperative agreement was written November 4, 1938. The semiannual report as of June 30, 1940, shows that there were 331 farmer-district agreements taking in a total of 46,298 acres. The following information should be helpful to other districts throughout the country, or to communities contemplating organization of districts:

Soil conservation practice	Planned	Established
Contour cultivation.....acres..	12, 188	7, 591
Contour furrows and ridges.....do....	12, 185	5, 700
New pasture.....do....	8, 018	3, 213
Old pasture planted.....do....	6, 671	2, 240
Farm pounds.....acre-feet..	¹ 131	² 172
Strip cropping.....acres..	1, 419	1, 047
Terracing.....do....	8, 962	2, 896
Woody plantings.....do....	645	385
Cover crops.....do....	6, 952	2, 352
Controlled grazing.....do....	2, 242	1, 693
Diversions.....rods..	3, 324	1, 525
Outlet channels.....do....	3, 468	1, 181
Meadow or pasture strips.....acres..	429	297
New fencing constructed.....rods..	45, 353	³ 16, 095
Old fence removed.....do....	17, 798	⁴ 6, 593
Gullies treated.....number..	2, 093	1, 187
Rotations approved.....acres..	15, 348	5, 877
Weed control.....do....	18, 423	6, 404
Woodland protected.....do....	812	472

¹ 47 ponds.

² 32 ponds.

³ 50 miles.

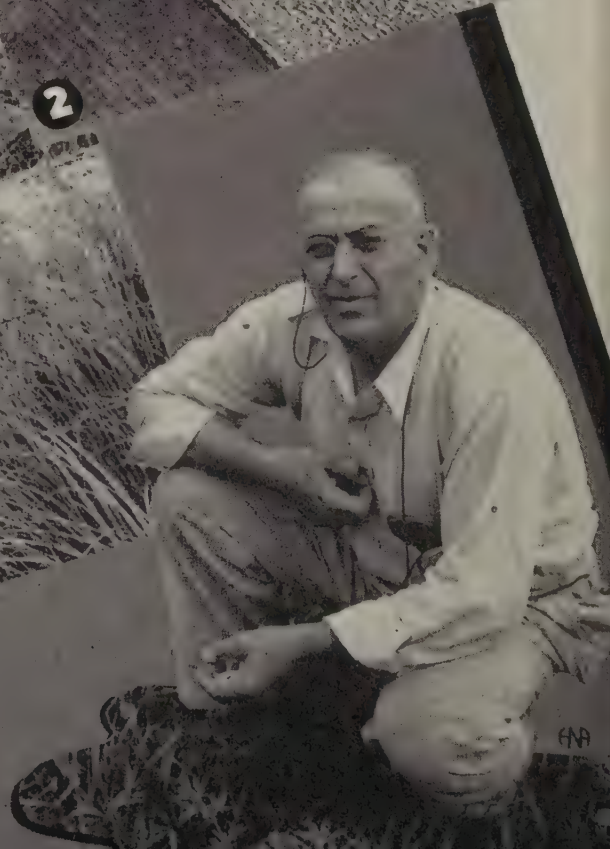
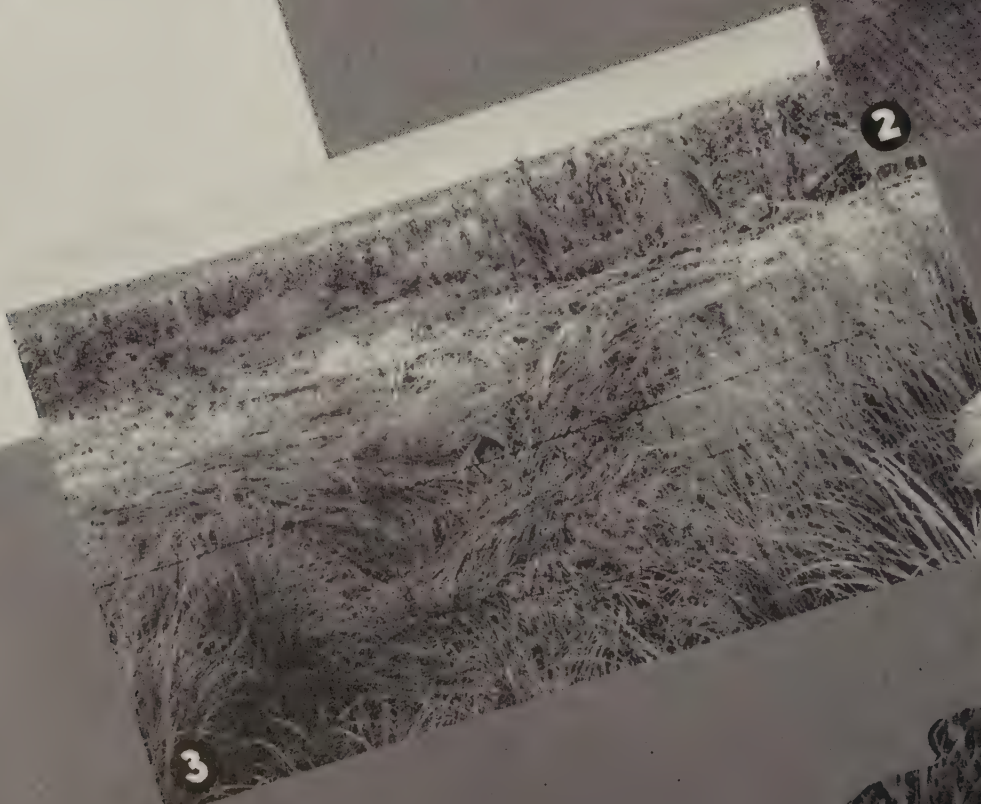
⁴ 20 miles.

The report shows that on 49 farms totaling 4,998 acres, a complete coordinated erosion control program has been established. We still think we were right when we decided that priority would be given to the farmer who had his team hooked up and ready to go.

In the Kannah Creek Soil Conservation District near Grand Junction, on the western slope in Colorado, the productivity of galleta is being greatly increased by flood irrigation for about 6 weeks in the spring, on sites where this practice can be used to advantage. Occasional furrows are used to control the flow of water. Shadscale, one of the saltbushes quite common there, is first stimulated in growth and then killed by the continuation of this use of the flood waters from melting snow on nearby Grand Mesa.



OF THE FARMERS BY THE FARMERS and FOR THE FARMERS



THE other evening I stood before a map of Pawnee County, in southeastern Nebraska, which hangs in the bank president's office at Steinauer. It had been colored, section by section, as the Turkey Creek Soil Conservation District grew and now the green, yellow, and pink squares cover well over half of the county and extend into the neighboring counties to the north and west.

"Too bad that map wasn't made 40 years ago," remarked W. A. Steinauer—he's the bank president and chairman of the district's board of supervisors. "We have worried about gullies and erosion, but we didn't know what to do. We tried many things throughout the years, and then the C. C. C. camp, operated under the supervision of the Soil Conservation Service, showed us some more. Some farmers tried farming across the hillsides and that did some good. It's probably the reason we organized the district."

Yes, the farmers organized the district which now stands as a fine example of what soil conservation districts should be . . . organized in fact by the farmers . . . growing because the farmers seek admission . . . the Soil Conservation Service truly in the position of an assisting agency . . . maximum accomplishments with a minimum of personnel . . . acute interest among the farmers in the progress of the district program, now being extended to the land according to the needs of the different kinds of lands and the economic circumstances, for the benefit of the people.

The Turkey Creek Soil Conservation District was the third district to be formed in Nebraska, and the first in the State in which all the lands were contiguous. Behind its organization is a story which rivals fiction. Its existence is a tribute to the determination of a small group of farmers, once rebuffed but not content to let the matter rest. It took courage, but they saw a job to be done.

The first proposal for organization was made early in 1937, the district to include all of Pawnee County and half of Gage and Johnson Counties to the west and north, respectively. It was beaten at the first meeting, a somewhat uproarious affair at the Pawnee City schoolhouse attended by several hundred persons. Lack of understanding of the district objective and plan of operation indicated that there was little chance for the establishment of a district within the near future.

Notwithstanding this first failure, the Turkey Creek district was organized only 18 months later, however, by an overwhelming majority. It took in 63 thousand

BY A. E. McClymonds¹

acres of the Turkey Creek drainage, in the northwestern portion of Pawnee County and on the fringe of Gage and Johnson Counties. The voting on December 28, 1938, spelled success for the small group of farmers who would not quit. They enlisted their neighbors, one by one, until there were enough to organize. Boundaries were drawn at a meeting at the home of Emil Rinne, about 18 miles north of Pawnee City, and later presented to a meeting at the Teckmeier school for confirmation. It was slow work, but when it was completed this community that wanted help in soil conservation was united.

Today the Turkey Creek district embraces 163,000 acres, and 25,000 more acres are expected to be added soon. The earlier additions were made by petitions, each signed by less than 25 farmers. There have been 15 of these, totaling more than 60,000 acres. The newest addition was by referendum, which brought 40,000 acres of the Mission Community in southwestern Pawnee County into the district in one lump. This also is the first and only addition to a district in Nebraska by referendum. It missed the charmed circle of unanimous approval because one of the voters, an elderly woman, had forgotten her glasses and made her mark in the wrong square.

The first proposal to form a district followed by a little more than a year the establishment of soil conservation demonstrations by the Soil Conservation

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AND THIS IS WHAT THE PICTURES MEAN—

1. *The use of sod dams converted a gully into a series of small ponds. After the former gully has been fenced, wildlife will be welcomed. The surrounding land has been placed under a system of contour farming.*
 2. *Air view of gully repair on a cooperator's farm. The former gullies are now grassed waterways which carry run-off from the terraced and contoured farm. The water is disposed of in such a way as not to damage the other farm.*
 3. *A sloughgrass-sodded flume just after a heavy rain. It is at the lower end of a terrace outlet channel on the farm of E. R. Bredemeier, secretary of the Turkey Creek district, and it shows the quality of protection against water erosion provided by this kind of terrace.*
- Lower right.—W. A. Steinauer, chairman of supervisors, in a field of alfalfa and brome-grass on his 230-acre farm.*

Service through the facilities of the C. C. C. camp at Pawnee City, started in the fall of 1935. All in all, the camp worked on 102 demonstration farms, 15 of them in the original Turkey Creek district area. There is no need for a play-by-play account of the camp's accomplishments; suffice it to say that this work and the confidence engendered by Camp Superintendent E. R. Danielson, had a strong bearing on the determination to form a soil conservation district.

Historically, the region in which the Turkey Creek Soil Conservation District is located is interesting. Southwestern Pawnee County is part of the Otoe Indians' territory. The rest of the county is part of the homeland of the once powerful Pawnee Nation, the principal village of which was located at the site of Pawnee City, the county seat. When it was discovered, the region supported a tall grass vegetation . . . big bluestem type . . . with trees plentiful on the bottomlands along the stream courses. Buffalo were in abundance and the principal creeks probably were continuous—at least Turkey Creek was a perennial stream as recently as 15 years ago; today there is not a continuously running creek in the whole county.

Settlement started soon after Nebraska and Kansas were thrown open to homesteading in 1854, and Pawnee County is the oldest settled portion of Nebraska. Burchard was the first village established by the white men. The first intensive settlement was in the vicinity of the Presbyterian Mission, established in 1857 for the Otoe Indians. It was this Mission Community, still intact, that brought 40,000 acres of land into the Turkey Creek soil conservation district by referendum.

The land is moderately to steeply rolling, with well-defined drainage systems. The rich soil was developed under a tall grass vegetation, over glacial drift material thinly capped by loess on the hilltops. Ground-water supplies depend upon seepage, because of the impervious bedrock that underlies the region.

Originally, cultivation was confined to small patches of land in the stream bottoms; the uplands were used for grazing. Gradually, more and more land was put under cultivation until today only about one-fourth of the county remains in grass. The agriculture of the region is, basically, general farming. Corn, wheat, oats, barley, and alfalfa are the principal crops. Among the livestock, hogs and cattle are most numerous but there are many sheep. As a result of recent drought years, the number of livestock has decreased.

There are still old-timers in the county who tell of driving from Pawnee City to Marysville, Kans., as

the crow flies—a distance of 30 miles—without crossing a bridge . . . “Without the horses' hooves hitting a plank,” they put it. The picture is vastly different now. Pawnee County exhausted its road funds trying to build and maintain bridges and culverts over drainages that carry run-off—increased run-off—from the fields and overgrazed pastures.

Ancient as it is in Nebraska history, this land has been used less than 90 years—the first cultivation was about 1855—much of it less than 60 years. Yet, when the Soil Conservation Service first came on the scene with the C. C. C. camp, every farm was gullied. Many gullies are as much as 25 feet deep and are cutting back into the fields rapidly. Sheet erosion also has taken a heavy toll, so bad that several hundred acres have been abandoned for cultivation, some as long ago as 25 years, and still native grasses have not come back naturally. Crops generally averaged less and less as erosion progressed.

Average precipitation in this area is slightly more than 30 inches and stories of water shortages seem strange, but they reveal how really pernicious are the gullies where the population must depend upon ground water stored above the impervious bedrock. Loss of precipitation through run-off is great, as a result of up-and-down-hill farming, but it is the deep gullies which serve as undesirable drainage ditches and allow the ground water to escape. As a consequence farmers tell of wells going dry part of the year nowadays, and others tell of wells going almost dry. During the drought years the water situation was serious. Crops, too, suffered from the excessive draining of the land. There was plenty to worry about.

A much more forward-looking attitude is evident now, as the district supervisors and farmers assisted by the erosion control technicians tackle the big job.

“The farmers like the idea that their cooperation is voluntary and that they get the technical assistance when they ask for it,” said Mr. Steinauer. “We like it that way, too, because when assistance is asked for, we know it is wanted. These farmers know the importance of farm planning . . . they have always planned to some extent . . . and they understand crop rotations pretty well because of the work done by the Nebraska Extension Service and the things they have read in farm magazines and newspapers.

“Many of these people have lived on their farms for years and know their land rather well, but they are glad to get an analysis of the erosion on their farms, the present capabilities of the land, and the recommendations for changes in land use.

“All of this farm planning is done by the farmer,

aided by the technician, and always there is the realization that the farmer still must make a living so that changes can be made only as fast as he is financially able. This combination of the technical knowledge of the Soil Conservation Service and the practical knowledge of the farmer is good . . . it is a way to get first things done first in putting a farm under conservation management."

The technical staff was assigned in April 1939, D. E. Hutchinson being chosen as district conservationist. With him are an assistant conservationist and a clerk. An engineer was assigned to the district for about a year. Two technicians are attached to the Pawnee City C. C. C. camp. The camp furnishes assistance in labor and material. To date, this staff has completed more than 100 signed agreements, and is taking care of the rest of the 300 applications as rapidly as it can. The acreage represented by the applications totals over 51,000 acres, and more are coming in with regularity.

The principal problems, stated briefly, are to develop a good sound farm management plan, check water erosion, conserve as much water as possible for crops and ground water storage, and dispose of the excess water in such a manner as to prevent erosion on the cooperator's farm and also protect the farmer lower down the drainage from damage. That's not just the way it is stated in the work plan, but it is the farmers' interpretation of the farm plan. This was told to me in a cornfield about 16 miles northwest of Pawnee City where I talked to Gottlieb Rinne. His cornfield is now cultivated on the contour. He has been on the farm more than a quarter of a century.

"If I don't have contours and terraces, the water from my farm will wash his land," he said, pointing to his neighbor's place. "I think that working together like this is one of the big things about soil conservation."

In cold figures, the work already done on the farms of cooperators is this: Six thousand acres put under contour cultivation; 500 acres of pasture contour-furrowed; 800 acres of land retired from cultivation and seeded to grass, principally brome grass and alfalfa; 300 acres protected by terraces built up to specification, and the farmers are building up many more by gradual stages; 40 acres of tree plantings; 150 acres planted to vegetation that will benefit wildlife; small gullies leveled or filled in and seeded with vegetation that provides stable waterways for disposing of excess run-off and some gullies dammed to provide stock water ponds. Control of the watersheds of the larger gullies is already under way, and plans have

been drawn for establishing ponds in some 30 of them.

To summarize, the district is providing for proper protection and use for each acre on every farm. These are the cold figures, but they do not tell of the spirit of the farmers, nor the changes—the renewed hope, the determination to provide securely for the land and to conserve rainfall—that are coming over the community.

"Yes, I have lots of crooked rows," Gottlieb Rinne said, "but I wouldn't go back to the other way for anything. Do I intend to keep on after the 5-year agreement is over? You bet I do. I didn't believe it when they told me it would take 5 years to put the farm plan in operation, but, by golly, it *will* take me that long."

"Say," he said, turning to Hutchinson, who was with me, "can you get that two-way plow out here pretty soon? I think I'll put in those pasture furrows now . . . about a rod apart, what do you think?"

Hutchinson agreed, and Mr. Rinne turned to me again: "I've got one terrace over there [pointing] and I'm going to put another there. The thing that sold me on terraces was this August when we had 14 inches of rain and I saw the water running lazy and clean along the terrace channel.

"Say, Hutch, I was plowing on that west hillside the other day and just for fun I turned the tractor uphill. I had to go into low right away, but on the contour I moved right along in high. It sure makes a difference."

This enthusiasm and spirit of cooperation is spreading. It is remarked that in one community where S. C. S.-C. C. C. demonstration farms were located in a group, conservation farming has increased the ground water and there is more water in the shallow wells all the year around. Another C. C. C. demonstration is pointed out—the Nicholas Klein place, 8 miles northwest of Pawnee City, which was put on a conservation operations basis. A deep gully was eating into the farmyard and the well there had so nearly dried up that it didn't furnish enough water for family use. The gully was dammed. It collects and holds the drainage water now, and the Klein well gives all the water needed for home and stock. Fish planted in the deep pond that was built to conserve water, now furnish sport as well as fish for the table. Moreover, ducks are now coming to the Klein pond. As many as 40 people have been seen swimming there in a single day in summer, and in winter there is ice skating.

"Does it pay?" Emil Rinne repeated to my query. "You bet it does. Some of the fellows asked how I

expected to get 40-bushel corn from my land. Well, it's producing 40 on the average. One field went 79 bushels. It's all contoured and terraced. We had 14 inches of rain in August and we didn't lose any of it. Man, the ground's really soaked!"

Fortunately, these farmers also realize the relationship between forage production and livestock on the farm, but pasture management was something that needed developing. It is taking hold rapidly now, however, probably as a consequence of results obtained on section 9, where the S. C. S.-C. C. C. camp took some worn-out pasture land, eliminated weeds with a close-growing crop, seeded grass, and then followed with a rotation grazing plan. Income from the section during the period of repair exceeded previous income, and the land is fully productive again.

"But this careful planning of farm operations is bound to help," is the reaction of Emmett Wenzl, 5 miles north of Pawnee City, who is first getting his land under a conservation system preparatory to controlling a huge gully. "It takes a little time, but the difference between a properly contoured farm and one farmed by the old system is just a matter of getting used to it. I'm staying with contours."

Perhaps one of the most interesting developments is the changing viewpoint of farmers and townspeople alike. The bitter opposition at the first meeting in 1937 centered on the fear of regimentation—farmers want to retain control of their land, and particularly these farmers because so many are long-time residents and even descendants of the first settlers. The occupancy survey shows how intense is this feeling of "my land." Forty-three percent of the farms are owner-operated and just under 12 percent are operated by men who own part of the land. The rest is tenant-operated, but a large proportion of the tenants are relatives of the owners. The average size of farm is 201 acres, although there are a few approaching 1,000 acres and a few that are little more than acreages—a couple of acres or so.

Neighboring farmers watched the Turkey Creek district closely. The regimentation did not show up . . . the farmers in the district went to work enthusiastically . . . their own supervisors ran the business . . . there was no government agreement, except with the supervisors to help carry out the farmers' program. It worked. Other farmers decided they wanted help too, and petitions were circulated. The first addition was made in December 1939, just a year after the district was organized. Listen to Everett M. Barr, a director of Tarkio College (Missouri) and farmer in the Mission Community.

"We have real problems here and must have help in meeting them," Mr. Barr said. "They are our problems, however; it's our land that is at stake and we are the ones most concerned with the results. The soil conservation district is the right approach, and the viewpoint of our people toward the district has changed considerably since it has been operating."

Farmers are not the only ones who have been taking an active interest. Harold Vance, vocational agriculture teacher at the Pawnee City high school, has gone out into the field and worked with the Soil Conservation Service technicians so that he can bring conservation training to his students . . . I mean worked, not watched. He and the class are helping to plan and put on a conservation basis the farm of a member of the class whose father died about a year ago.

"The soil conservation district plan opens a wide field for the agricultural teacher," Vance declared. "His course can be made dynamic because it can bring something tangible to the boy from the farm. To me, it seems as a big laboratory which I am glad has come my way."

The laboratory idea is spreading. The State college of agriculture is conducting a farm management study, the State game commission is carrying on a quail restoration project, and the agricultural college and the Soil Conservation Service have joined in a pasture study.

While the motive power that propels the district forward comes from the people, the educational side is not overlooked. The supervisors have appointed 34 members to act on a committee to assist in carrying on the educational program. These persons are all outstanding conservation farmers. They schedule the meetings, which are nearly all neighborhood affairs with small attendances. The visitors are shown pictures and told of the newest developments in conservation, while discussions bring out suggestions from the farmers who are encouraged to study conservation methods critically and even to experiment. Some of the meetings are attended by people from outside the district, and many take the ideas home for trial.

In the meantime the board of supervisors runs the business of the district. The present supervisors are the members of the original board, all of the small band who organized the district. Once a month they gather around the long table in the bank, Mr. Steinauer and secretary Edwin H. Bredemeier at the head of the table, and the others, Emil Rinne, Steven Kalin, and

(Continued on p. 208)

THE BANKER'S PART IN SOIL CONSERVATION DISTRICTS

By WALTER S. COTHRAN¹

WE all know that lending money to farmers carries a problem different from any other banking problem; and yet, let me remind you of one striking analogy:

A merchant or manufacturer brings in his financial statement to you. It shows a capital loss from the preceding year. You do a lot of investigating before you lend him the money. The next year his statement shows about the same loss of capital; you don't need to investigate; you've seen enough, and without the least hesitancy you decline to make the loan. The funny thing is that you go right on making loans, year after year, to another class of borrowers who every year suffer a loss of capital. That is, the farmer, whose soil, his capital, is constantly slipping away from him because of lack of proper protection, which in turn may be due to lack of funds, or lack of knowledge as to how to save his soil.

I shall not discuss soil waste. We bankers fully realize its cost to our State, to its farmers, and to its bankers. Let us discuss the subject of what we are going to do about it. I say "we" advisedly, because we bankers very definitely have our place in the picture.

With so many fields of endeavor offered to us, so many varied activities demanding our time, so many other problems of the banking business requiring our thought, we must never for a moment forget that Georgia is still primarily an agricultural State, needing banker help for a successful agricultural program, and our efforts and attention must not be distracted from that objective.

I don't think many of us bankers could lay off a terrace for our farmer customer. I don't think we could tell him where to plant lespedeza or crimson clover in a field of strip cropping. I don't think we could plan a good water disposal system for him; in fact, I think we would be a pack of fools if we tried. What we can, and should do, is to use our influence with farmers to induce them to take advantage of an opportunity now being offered to them. I hope the opportunity is lasting—certainly until all of our land is put to its proper and profitable use. These are functions of local soil conservation districts carried on

with assistance from the Soil Conservation Service and other agencies—local, State, and Federal.

Now, some of us may think that erosion is not such a danger in Georgia. If you do, listen to these figures: The total land area of our State is 37,568,000 acres. One sixth of it, or 6,455,000 acres, is severely eroded, and 16,181,000 acres are more or less eroded and definitely in need of treatment. That is to say, 1 acre in every 16 is in need of reclamation, and 1 acre out of every 2½ acres is in need of conservation.

The Soil Conservation Service maintains five demonstration projects in Georgia. There are 9 S. C. S.-C. C. camps in this State. Our farmer customers should see what is going on in these demonstration areas—even if we have to organize motorcades, and carry them. With farmers, as with the rest of us, seeing is believing, and they will see doings at these demonstration areas that are valuable and practical; they will see farm practices which they will want to install on their own farms; and they will gain an insight into the opportunities for neighbor cooperation through the soil conservation districts.

Very soon after the requisite national legislation was adopted by Congress, Georgia passed the soil conservation districts law, under which 19 districts are now organized, embracing 92 counties, and including about 22,000,000 acres.

I wonder if we really appreciate the value of the opportunity now offered to our farmer customers by the Soil Conservation Service and the soil conservation districts? I have heard of the interest being taken in it by many of you in Group Two—Mr. Turner of Jefferson, Charlie Bradford and Harry Arnold of Monroe, Ike Ferguson and Dewey Johnson of Augusta, Charlie Skinner of Waynesboro, Jim White of Athens, Mr. Westbrook of Ila, who is supervisor there, and many others. I know your interest and influence is not misplaced.

Some of you, though, may not know the value of this work, so I want to tell you of an interview I had last Sunday afternoon.

I sat on Noble Holland's front porch and listened to an interesting story. He told me he moved onto his farm in 1917. After working it for 20 years, he was so discouraged that, as he expressed it, "I was just ready to quit trying." He pointed to a field of corn, in a bottom, in front of his house and said that he

¹ The author is vice president of the National City Bank of Rome, Ga. This article is adapted from an address by Mr. Cothran at the annual meeting of Group Two, Georgia Bankers Association, Washington, Ga., November 20, 1940.

lost about one crop out of three, because of water standing on it due to improper drainage. His cotton land was washing away and had been doing so for many years. Three years ago the Soil Conservation Service laid out a farm plan for him which he proceeded to follow.

Another farm lay between his farm and a creek. That adjoining farm was also planned and through it drainage ditches were made which drained both farms. Now Mr. Holland's cornfield on which formerly the water stood and drowned out his crop, produces 25 to 30 bushels every year. On the cotton land, on which he has been planting soil building crops, he has already picked a bale to the acre, and he hasn't finished picking yet.

There is a tract of 80 acres adjoining him on the up-grade side. It was utterly unprotected, with the result that the water poured across Mr. Holland's farm. So last year Mr. Holland just up and bought that backward little 80 acres. A nearby bank, seeing the sort of farmer Mr. Holland was, and the fine improvement in his farm, and the increased income from it, was glad to finance the purchase. So now on this 80 acres, at last being operated under a soil conservation plan, I saw terraces with proper outlets, I saw strips of *Lespedeza sericea*, I saw kudzu on badly washed tracts, and cover crops on many acres. Mr. Holland told me that on his entire farm of 200 acres he had paid out \$182 for terracing, his total cash outlay in carrying out the plan except for a few seed he bought to start with.

I asked Mr. Holland, and also a soil conservation technician, what reasons were advanced by some farmers for not taking on the conservation plan. They seemed to think that one cause for hesitancy lay in the necessity of working 365 days a year. Other objections were directed to the initial cash outlay and to the necessary change from traditional ways of farming.

Bankers, as I said in the beginning, have a definite place in the picture of reclamation and conservation of soil. Yours is a position of influence in your community, especially with farmers. The active influence of a banker can do more for soil conservation than any amount of talking and preaching, in selling the farmer on the idea of taking full advantage of the service afforded by the soil conservation districts.

The other spot the banker occupies in the picture is providing funds for the initial cash outlay needed for terracing and fencing and so on, when the farmer starts his plan. As one farmer told me, "It takes just a little money but a lot of time, to save your soil."

As I see it, there is every sound reason for the farmer to take immediate advantage of the opportunity now offered under the soil conservation districts.

Already in the projects, camps and districts in Georgia, 5,037 farms with 929,107 acres, have been planned; 96,000 acres have been protected by terraces, 70,000 acres have been strip-cropped and 364,000 acres have been protected by winter cover crops.

This accomplishment is but the beginning of an excellent investment. I call upon Georgia bankers—bankers everywhere—to recognize the importance of the idea and the program of the soil conservation districts, and to embrace every opportunity to function as junior partners in an enterprise of such rich promise to the future of agriculture and of the whole social order.

OF FARMERS, BY FARMERS, FOR FARMERS

(Continued from p. 206)

Gaylord Sisco, around the table. Present by invitation to answer questions, are Mr. Hutchinson and Mr. Danielson. Make no mistake about it, the supervisors regard the district as the farmers' organization and realize that they are obligated to work in the best interests of many farmers.

One supervisor made this brief talk:

"Where are we going from here? Well, that's looking a long way into the future. With the district getting larger all of the time we've got a long job. Every farmer is encouraged to go ahead as fast as he can afford to, but no faster. Maybe it's slower that way, but it's better.

"I think that where we are going from here is toward a goal of building up the soil of every farm, controlling the water and conserving it, and then keeping our farms safe.

"The careful planning of farming operations, according to the needs of the land, and then equally careful application of conservation measures is the way to accomplish this. More than that, better farming according to correct soil and water conservation planning means greater economic security and higher standards of living for our people, and the spirit of voluntary cooperation that has become evident means that our community will advance. There's a lot more to soil conservation than just saving the soil.

"There are other things, too. A few years ago the county dropped the county agent because he was not needed, or so we thought. At the last election, the county agent was voted back in because the work of the district showed that we needed him, as well as the Soil Conservation Service. We probably will see other needs as we go ahead, but now that we are organized we can study each problem carefully and cooperatively and reach the right answer."

THEY KNEW WHAT THEY WANTED

BY FRANK B. HARPER¹ AND HAROLD E. RUSSELL²

FARMERS and ranchers of the Latah Soil Conservation District in northern Idaho believe it is "in the cards" that their new district organization will help them to more profitable use of their rich Palouse lands. The "cards" in which these Pacific Northwest land owners and operators read the future of a 694,323-acre area that includes some of the best cropland in the United States, or in the world, are mere strips of roughly lettered cardboard. Latah County's leading farmers marked them. They are used face up for the benefit of the 1,780 farm operators of the district. It is expected that by June 30, 1941, some 200 farmers will have staked their time and money on these pasteboards.

On March 16, almost a year ago, Latah County farmers went to the polls and voted to organize a soil conservation district under the Idaho State enabling act of 1939. They knew what they wanted; many of them already had had personal experience, or had observed closely as their neighbors worked to control erosion and to set up wise land use practices. Through a number of projects—the erosion control experiment station 9 miles away at Pullman, Wash., the erosion-control demonstration project near Moscow on the south fork of the Palouse River, the Moscow C. C. C. camp set up in 1935, the extension demonstration plans scattered throughout the country—the farm people of Latah County had learned of the benefits, to themselves and to their land, of planned farming and erosion-control practices. Their vote for a medium through which to carry on soil-conservation work, after the Government's projects might no longer be at hand, was preponderantly affirmative.

The Latah Soil Conservation District was set up, legally, as Ida-101, the first in Idaho. Actually, according to Chairman Henry Bottjer or any of the other four supervisors, organization of their district was not as simple as a mere name and number. The real work was to come, and the details were many and involved. The first thing they did was to invite the Soil Conservation Service, which had been heading up the local erosion-control demonstration work, to come in and help them with the new district's organization. Three full-time technicians were assigned to them—a conservationist, a farm planner, and an engineer—and it soon developed that these 3 men could not have

all the answers for upwards of 2,000 farmers operating over an area some 50 miles long and 35 miles wide—additional part-time assistance and a generous supply of memoranda notwithstanding.

Out of this dilemma, the card idea was born. The district leaders and assisting Service personnel knew that they must "grow" with the development of the infant organization. This first step, then, was the setting down, in rough-draft outline form, on cards, all available helpful information from past experience in the area, gleaned from the memoranda and all possible sources.

The first set of a dozen cards indicated the district's *line of authority*, from the 1939 district enabling act, through the State soil conservation commission and the Latah Soil Conservation District to the supervisors, and the "why, where and what" of the district program. A second set of cards, following logically the first, outlined the *reasons and objectives* of a district program and work plan, memoranda of understanding, planning through both individual and district-wide plans, and operations through individual farmer and group action.

In preliminary meetings, the supervisors already had decided upon half a dozen objectives as taking in the major problems of the district. These promptly became the backbone of the outline that later was to become the district's organization chart. Briefly, they are (1) prevention of erosion on the farm land, (2) conservation of water, (3) watershed protection, (4) woodland management, (5) range management, and (6) land clearing.

The supervisors called a meeting on July 18, to select 25 community advisory committeemen from among interested farmers in the district to function in a voluntary advisory capacity with the supervisors in the 5 subdistrict areas. Discussion of planning, operations, and objectives also was on the agenda. After the advisory committeemen had been named, the first two sets of organization cards were put up on the blackboard, as something of an abbreviated chart. As each of the main objectives was suggested by one of the leaders, the appropriate card was added to the growing organization chart.

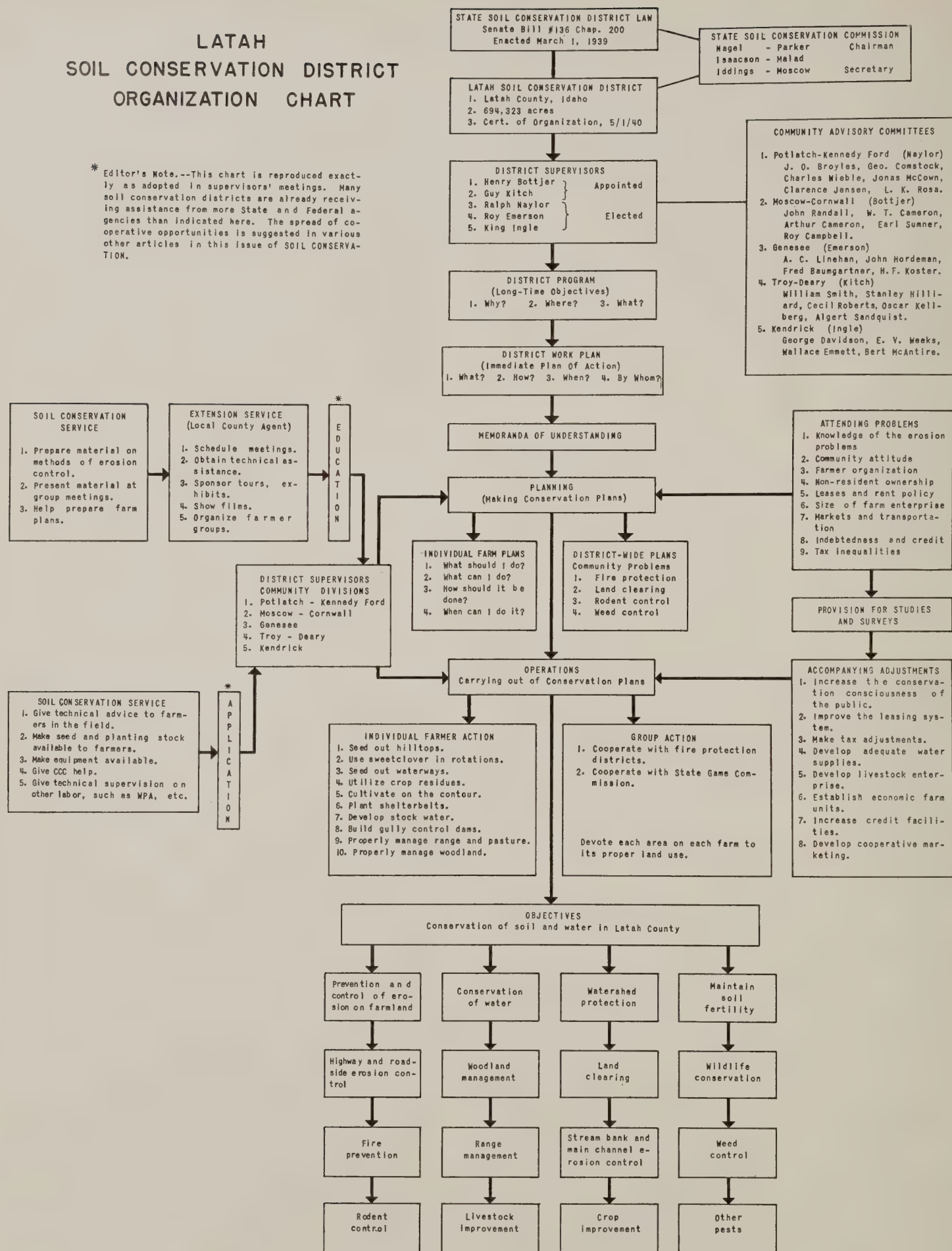
Suggestions for other specific objectives to be considered were invited from the floor by the chairman, with the result that 10 more cards were written in longhand and added to the chart, covering the follow-

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² District conservationist, Latah Soil Conservation District, Moscow, Idaho.

LATAH SOIL CONSERVATION DISTRICT ORGANIZATION CHART

* Editor's Note.--This chart is reproduced exactly as adopted in supervisors' meetings. Many soil conservation districts are already receiving assistance from more State and Federal agencies than indicated here. The spread of co-operative opportunities is suggested in various other articles in this issue of SOIL CONSERVATION.



ing objectives: Maintenance of soil fertility, highway and roadside erosion control, wildlife conservation, fire prevention, stream-bank and main-channel erosion control, weed control, rodent control, livestock improvement, crop improvement, and control of other pests.

The supervisors and advisory committeemen had come to the mid-July meeting with their sleeves rolled up—there was much to be done and now was the time to do it. The discussion turned next to conservation practices necessary to meet the objectives. To supplement the working chart that had been developed, large separate placards were put up and suggestions were asked for from the floor. The chart objective of "Conservation of Water," for example, prompted this list of specific practices agreed upon then and there:

- | | |
|---------------------------------|------------------------|
| 1. Rough tillage. | 6. Gully dams. |
| 2. Stubble utilization. | 7. Restricted grazing. |
| 3. Maintenance of timber cover. | 8. Fire prevention. |
| 4. Spring development. | 9. Chiseling. |
| 5. Stock ponds. | 10. Crop rotation. |

By the same procedure, "Watershed Protection" was tied down to:

- | | |
|-------------------------|---------------------------------|
| 1. Woodland management. | 5. Fire prevention. |
| 2. Range management. | 6. Reseeding burned-over areas. |
| 3. Reforestation. | 7. Proper slash disposal. |
| 4. Camp grounds. | |

During this meeting each of the 16 objectives was similarly worked out as to specific practices, the district supervisors and committeemen formally approved them, and all concerned decided to "call it a night."

The next job was to draft the district program and work plan. On these, too, the supervisors had definite ideas. One was that there should be group undertakings by the district, such as cooperation with fire protection districts or with highway agencies in roadside erosion control, as well as in the individual operator's land-use practices on his own farm. Another was that every landowner or operator in the district should have land-classification information, should know what is necessary for developing a complete soil conservation program on his place, and should be informed as to the percentage of the ideal plan that he can carry out economically.

As a result of careful thought and discussion, taking in all details, each Latah District farm plan sets forth, first, an inventory of the farm's erosion conditions, second, the ideal erosion-control plan for the unit and third, a statement of what the operator can do eco-

nomically toward effecting this plan within the next 2 or 3 years. In other words, every district cooperator's folder actually contains two farm plans instead of one—the ultimate ideal plan, and the immediately, economically, practicable plan.

The district organization chart and the supplemental-practices cards, once drawn up, were not by any means relegated to the district's minutes or files. They are in constant use at discussion and planning meetings throughout the district, along with soil-profile charts and other graphic material designed to help small groups of farmers to a clearer and quicker understanding of their new program.

The organization chart was expanded subsequently to take in two more sets of cards. On one set was outlined the cooperative relationships of the State extension service through County Agent G. T. McAlexander, who has been particularly active in assisting with district organization details, and of the Soil Conservation Service in educational responsibilities in the district. This group of cards also shows the place of the district supervisors and community divisions, as well as of the Service, in the handling of applications for district planning assistance. The final block added to the chart consists of a list of the community advisory committees, a statement of attending planning problems, provision for studies and surveys, and accompanying adjustments tying in with operations.

The Latah district supervisors, with Service personnel assistance, are building up their concrete working organization to conform to the individual farm planning accomplishment through a systematic schedule of group meetings. First is the over-all meeting in a community or district subdivision having more or less common problems. During the hour and a half to 2 hours of discussion, objectives and problems agreed upon by that community are considered, along with methods of approach suggested by the supervisors and an explanation of the group-planning objective to give the greatest amount of assistance at the least cost. Out of the over-all discussion meeting grow the unit planning meetings, the number depending on the applications from that area. Usually 8 to 12 farmers participate in the unit meetings, working together as neighbors.

The small unit meeting is predicated on the belief that before the farmer can understand what he is doing, he must know why, and he must be acquainted with the fundamentals of soils, land-use capabilities, and so on. Again, through the use of cards, these facts are built up in open meeting. Colored cards

representing the different land classes by soil and slope are pinned up on a profile graph, so that the farmer, when he receives his own conservation survey map later, will know at once how to interpret it. Either at this first unit meeting, or at a second one, specific practices are taken up. The farmers themselves suggest practices they think they should adopt, as well as those to be avoided.

After one or two meetings devoted to this discussion of practices, a planning meeting is held. A "dummy" map of a typical farm in the particular community is put up, and the farmers, without prompting from the chairman, present their suggestions for crop rotations, grass and legume seedings, retirement, woodland plantings, etc. The dummy map then is turned over and the proposals are checked against the farm organization summary with which the proposed revised field-uses must balance. More often than not, the farmers find that they must rework the dummy plan, to get the correct proportion of hay and livestock, for example, or to avoid having too much of the farm in one crop over a given year.

The farmers—the same group that has gone through all the unit meetings—now are ready to work out their individual farm plans. By this time, a conservation survey map is ready for each farmer and it is given to him with a farm organization summary blank on which he may put down his crop, livestock, and other requirements. Before the next unit meeting, the farm planner from the Soil Conservation Service goes over the farm with the operator and gives him whatever specific assistance he desires.

Each farmer comes to the final planning meeting with his own plan worked out in rough-draft. Sitting apart, the farmers spread out their plans and work to perfect them, calling upon the technician present for any further help they may need. Particularly with the aid of their A. A. A. farm maps, the operators at this meeting put their individual plans into shape for typing in final form at the district office. A final unit meeting is held for signing the plans.

Throughout the organization and planning procedure, the "block" system is followed. The conservation surveys, for example, are made in blocks of farms, the better to obtain complete protection on a watershed or drainage; or perhaps to provide a number of stockwater ponds in one area to facilitate the work of the cooperating Moscow C. C. C. camp crews.

The block approach works to advantage also in projects such as planning county road developments, and the handling of cleared timberland. For example, the Farm Security Administration loans on such lands

are made contingent upon conservation survey information available throughout the district, confirming the economic feasibility of the units involved. One private concern that has been doing cut-over timber clearing work in the district area, using a bulldozer, already has volunteered not to clear a piece of land if the district's conservation surveys show it should not be farmed.

The Latah district supervisors are enthusiastic about the organization and the planning methods that have developed with their still young districts:

"This is far ahead of the old type of planning," Chairman Bottjer said, recalling his own earlier and successful C. C. C. demonstration plan. "What the farmers don't like is somebody coming along and telling them what to do. Now they bring in their own plans and work them over to see what can be done . . . The cards help a lot; if a fellow can see a thing, he gets a better impression of it. We're just getting started but I think that if we follow those cards right along, we'll not have any trouble or get tangled up."

Supervisor Guy Kitch, who has attended several sets of the overall and unit meetings in his district subdivision, commented thus: "If we were going to do it again, I wouldn't know a better way than by the use of these cards and charts." Then, rather ruefully, he added, "If I can be as successful in erosion control as I have been in starting this erosion, I ought to get results. I can't blame anyone else because we broke the place out from timber. In my opinion, I think our method of organization is important; it gives each man an interest in the district program and a sense of responsibility he would not get if the plan were just handed down to him."

Supervisor Ralph Naylor was one of the first erosion-control demonstration cooperators in the county, and he remarked that his farm is "getting better all the time," with 40-bushel wheat now where he used to raise only 30. "These little neighborhood meetings are the thing. It is the real way to get the problems threshed out," he said.

At these meetings, which the Latah district farmers attend with so much enthusiasm, will be found the two other supervisors, Roy Emerson and King D. Ingle. The full-time Soil Conservation Service district staff, in addition to the district conservationist, is composed of Verle Kaiser, farm planner, and Louis Wakefield, engineer—these men will be there too, whenever possible. The district uses also the one-third time of a forester and of a range man, while mobile surveys assistance is available when needed.

A DISTRICT SAVES WATER WHERE IT FALLS

An Interview with a Supervisor

BY TOM DALE ¹

THE Central Curry Soil Conservation District in New Mexico has been enlarged three times in 2 years. It covered only 410,000 acres as first organized, but today it includes all of Curry County—approximately 890,000 acres.

A. J. Reid, 53, is chairman of the supervisors. He owns 560 acres of land, farms an additional 550 acres. A cooperator with the Soil Conservation Service on the old demonstration area, Mr. Reid is an active proponent of soil and water conservation for the Southern Plains.

He was appointed supervisor of the district by the State committee at the time it was set up in the fall of 1938. His first appointment was for a 2-year term; recently this tenure has been extended for another 3 years.

Born and reared on a corn-hog farm in Alabama, Mr. Reid at 21 left for southwest Oklahoma. A year later, in 1909, he settled in Curry County. His 31-year residence makes him one of the old timers. He has been growing wheat to some extent ever since 1916 but has never been a single-cropper.

The 500 laying hens on the Reid farm, from which \$136.20 worth of eggs were sold in November 1940, are the principal sources of cash. He markets about 300 turkeys each fall. Usually he keeps 5 or 6 brood sows. He depends on the chickens, turkeys, and hogs to eat up most of the sorghum feed produced on the farm. He also has some 30 head of cattle.

Mr. Reid thinks that soil conservation in Curry County must start with water conservation. He is an apostle of terraces and contour tillage to hold the water. All the cultivated land on his farm has been terraced for several years. The land he is renting next year also is terraced.

"We have to save the water to make crops and conserve the soil in this country," Mr. Reid contends. "We call this a flat country but you'd be surprised at the amount of water that runs off into the draws and wet-weather lakes during heavy rains. This country doesn't wash away as it did in Alabama, but soil conservation is important wherever farming or ranching is done.

"Soil conservation districts seem to me to be the best way to get the job done. They give us local govern-

mental agencies with authority to act and to receive aid from Federal and State agencies."

The Central Curry Soil Conservation District was a natural outgrowth from the demonstration project of the Soil Conservation Service that was established in Curry County in 1937. Since the district has been organized, 113 farmers within its boundaries, farming 144,214 acres, have signed agreements with the district to install a complete soil and water conservation program on their farms. This is in addition to farmers living in the district who already were cooperating with the Service in demonstrating erosion-control methods under agreements signed with the old demonstration project.

When asked what he considered to be the most important thing that the district had done since it was organized, Mr. Reid said, "I think the most important thing we have done is to make the people of this county conscious of the fact that we have a soil conservation problem."

He was high in his praise of the men from the Soil Conservation Service and of the county agent, who had been assisting the district in its program, and mentioned the valuable help received from the Farm Security Administration and other agencies. "The district set out to get all agencies to assist on our program and you'd be surprised at the way they are cooperating with us."

The supervisors of the Central Curry District have encouraged farmers to develop new methods of constructing terraces. One man recently bought a small elevating grader and after terracing his own farm has started doing contract work for his neighbors in the district. The one-way plow and other implements found on most farms in the county also are used to build terraces. The supervisors feel that the terracing program will never spread as it should until farmers learn to build terraces with their own equipment.

Mr. Reid thinks that one of the greatest needs is more interest in small communities and farm homes. "Too many people are moving to town and farming from a distance. Trees, flowers, yards, and gardens are worth a lot more to this country than their cash value. Pride in farms and farm homes is needed," he declares. "We have made more real progress during the last 4 years than in all our history."

(Continued on p. 232)

¹ Chief, regional division of information, Southern Great Plains Region, Soil Conservation Service, Amarillo, Tex.

A NEW MAP IS TRACED



BY THE MEN OF THE SOIL

And the Farmers' Soil Conservation Districts
Look to the



Soil Conservation Service

For technical services, labor, field equipment, materials, and leadership bearing on the district program.

Extension Service

For leadership and coordination of College, State, and Federal educational activities.

Farm Security Administration

For cooperation in rendering financial assistance to farmers.

Agricultural Adjustment Administration

For financial assistance through payments for soil conservation practices.

Bureau of Agricultural Economics

For broad economic planning, harmonizing of local land-use activities.

Forest Service

For technical assistance, equipment, materials, and labor in connection with work primarily in large forested areas.

Other Agencies

For other needed assistance.



States in which a Soil Conservation Districts Law has been enacted. (38 States)

Soil Conservation Districts determined practicable and feasible as of Nov. 15 1940 (420 Districts)

252,000,000 acres



PUTTING THE DISTRICT IDEA TO WORK ON MICHIGAN'S LAKE SHORE

BY MELVILLE H. COHEE ¹

“THE farmers have realized for some time that they were confronted by some serious erosion problems and because of this realization they formed the district. Cooperation is beyond all expectations. The farmers are anxious to help plan their farms and do all they possibly can to help the program along.” This statement appears in an early report of the governing body of the West Ottawa Soil Conservation District, covering the period from January 1, 1939, to June 30, 1939.

“The attitude of the farmers toward the program continues to be excellent. Farmers are anxious to become cooperators and are very willing to accept the responsibilities placed upon them by the farm plan.” These two sentences appear in the second paragraph of the report for the period July 1, 1939, to December 31, 1939.

What are the soil conservation and erosion control problems that moved the farmers, representing approximately 1,400 farm units to vote overwhelmingly in favor of a soil conservation district—802 votes for and only 11 votes against? Why was it that the governing body of the West Ottawa Soil Conservation District met 16 times of its own free will and accord between May 9, 1938, when the district was organized, and December 31, 1938, and 6 to 10 times during each succeeding 6-month period.

The problems of these land owners and operators had not originated a mere year or two before the State soil conservation districts law for Michigan was passed in the spring of 1937 to become effective on October 19 of the same year. Their land-use and soil conservation problems had been accumulating for many years and, unfortunately, the people of what now constitutes the West Ottawa Soil Conservation District were not the masters of regional and national influences and general economic conditions that were causing serious erosion problems in their part of Michigan. The farmers do recognize and admit that they had some part to play in the abuse of their lands—they were the uninformed users of the soil. Today they are starting to correct, insofar as it is within their ability, those unwise land-use practices that allowed the wind and rain and elements of nature to mutilate their soils and destroy productivity.

Yes, the problems which these people are so enthusiastically attacking today go back a long way, as we reckon periods of time in America. They are exemplified at their worst by frequent references, made by members of the governing body, to the more than 30,000 acres of land within the district which is “on the move.” One need not go outside this particular district to appreciate the seriousness of soil erosion in the southwestern part of Michigan: Seventy miles to the southwest, still in Michigan, buried in the sands is the town of Singapore; and at an equal or greater distance to the north and northwest of the West Ottawa district, farmers are facing the same serious problems.² Altogether too few people in this country realize that soils may “move like mountains” before the strong winds, literally covering all vegetative life, and as certain diseases kill their victims gradually, so do the moving soils slowly crowd people out of their homes whether they are rural folk or urban. And just as definite as are these outstanding examples of concentrated localized erosion, such as buried Singapore, so is there a deep-rooted effect upon society, will be throughout the whole country if from east to west and north to south the people do not rise up, as in war, against continuation of land-use practices that permit devastation of soil resources. Fortunately, for the land and the people, landowners and operators familiar with the soil conservation district philosophy,³ and the effectiveness of its approach, seem to feel that they now have at their disposal the “machinery” and ambition to “wage war” on “old man erosion.”

The beginning of the obliteration of such thriving community centers as Singapore goes back nearly 100 years. Farmers, lumbermen, and in general our American social system had not even begun to appreciate what would be the consequence of the wholesale removal of timber in the west lake-shore area of Michigan—and for that matter, in other parts of the country—without foresight to the future erosion problems.

The love for the soil and appreciation of its proper use is today well beyond the embryonic stage in America; but it has not yet developed to that point

¹ Chief, program procedures division, Soil Conservation Service, Washington, D. C.

² Tzintzuntzan to Singapore, by H. H. Bennett, *SOIL CONSERVATION*, September 1940.

³ Self-Governing Principles of Soil Conservation Districts, by Melville H. Cohee, *SOIL CONSERVATION*, December 1940.

reached so long ago in many parts of central Europe. Experiences have proved, in the older countries, that local community interest, with wise administrative management provided through appropriate governmental tools of regulation, will bring not only appreciation of the economic benefits from soil conservation, but also a certain stamina of the social system that enables it to withstand the strains of economic misfortunes.⁴ There is no doubt whatever that the social machinery that has been set in motion through the soil conservation districts will do much more than serve merely as preventatives of future "Singapore tragedies."

But specifically, what are the tangible problems facing the people in the West Ottawa Soil Conservation District and how does the district, as such, provide an avenue of solution? First of all, it should be remembered that this district, like all others in the country, is a self-governing, autonomous organization with powers germane to any governmental body that is corporate and politic and a subdivision of the State, but in this instance such powers are specifically designed for "the conservation of soil and soil resources of the State, and for the control and prevention of soil erosion . . ." Of the 132,152 acres in the district, only about 12 percent have been considered by the governing body as first- and second-group agricultural lands in its present condition. When the land in the district was considered further to determine its possibilities for intense agricultural use, it was found that approximately 42 percent of it was mostly nonagricultural. As of March of each year, the time of settlement for taxes, 35 percent of the land in the district was tax delinquent for 1935, 26 percent for 1936, and 25 percent for 1937. Over the past 40 years, corn yields had dropped to an average of 20 bushels per acre; rye to an average of 10 bushels per acre; wheat to the low average yield of 15 bushels per acre, and oat crops had fallen to the average yields of only 25 bushels per acre.

Farmers of the district had come to realize that their sandy soils could not longer endure the erosion abuse to which they had been subjected. As is frequently the case, the agriculture of the district was not of a type to afford adequate living standards for the farm operators and their families while yields remained at such low levels, and thus it was not unexpected that the extent of tax delinquent land should amount to such sizeable areas. Nevertheless, the land owners and operators believed that if they could stabilize the soil and rehabilitate it, then the communities could

again become self-supporting and perhaps prosperous. In some parts of the district many shifts in land use should be made; the district governing body, with the land owners and operators, generally recognize this necessity and are anxious to make those necessary overall adjustments that will facilitate the changes in cultural practices essential to control erosion and at the same time retain or improve the economic conditions of farms and other units.

The governing body of the West Ottawa Soil Conservation District, called directors under the Michigan soil conservation districts law, recognized at the outset of their operations, in August 1938, that even though the farmers were enthusiastic about the soil conservation and erosion control work, they still needed specific information on how to go about the job. The directors, therefore, provided in their work for district operations that sufficient educational work should be carried on to acquaint the farmers within the district with the soil erosion and conservation problems involved, the proposed district plan of operation, the progress and results of district work, and the provisions of written agreements embodying individual farm plans to be entered into between the district directors and the individual land owners and operators. In this part of their work the directors planned to call upon the Extension Service, especially through the county agent and the extension soil conservationist.

Furthermore, at the outset of district operations, the directors anticipated that organized farmer groups and committees would be needed to assist in developing community interest, arrange for proper meeting places for the local groups of farmers, assist in notifying farmers regarding such meetings and activities, and in holding tours, field days, etc., and assist in other ways in furthering the district program.

The directors planned that other special types of assistance to the district, particularly that from the Soil Conservation Service, would be used for direct assistance to land owners and operators in preparing individual farm conservation plans. These plans take into account not only each acre of the farm but the erosion control practices essential to a soil-conservation program for the farm as a whole and for the community. The district needs as well as those of the individual farm should be considered in making the farm plans. The directors also recognized in their planning that several other local State and Federal agencies could assist in the big task confronting the people of this district.

Fortunately the land owners and operators of this district had a real understanding of their problems

⁴ Soil and Men, by Carle C. Zimmerman, Professor of Sociology, Harvard University. Land Policy Review, July-August 1939.

even before they organized, and the county agricultural agent had appreciated the needs so that he was able to help greatly with the work of the county planning committee. During the winter of 1936-37, this group determined that about 50,000 acres of land within the district was badly in need of immediate attention, and they agreed that a real reforestation program was necessary in order to control erosion on so large an area. Since the members of the governing body of the district had worked with the planning committee before the district was organized, they were in an advantageous position to tackle their undertakings. Furthermore, the county agent had been successful as early as 1934 in getting the county board of supervisors to appropriate \$50 for use in establishing a few farm seedbeds whereby the farmers could produce their own seedlings for the reforestation of their blowing lands. Despite the fact that of the three beds established from this small appropriation only one came through about 30 percent, the idea had not died—the damping-off disease which had ruined two of the seedbeds and two-thirds of the other did not “dampen” the interest of the local farmers and the county agent.

In the fall of 1935 the county board of supervisors appropriated \$75 more for seedbeds, and with this money 16 beds were started and to a considerable extent were successful. More important than the actual success of the seedbeds was the fact that the local leaders now became imbued with a greater will to carry on a broad program. The conservation committee of the county board had become vitally interested and after a thorough examination and review of the entire land use and erosion situation of their local territory the board of supervisors in the fall of 1936 appropriated \$1,500 for use by the county agent and his followers in continuing their reforestation and erosion control program. Thus it was possible, in 1937, that a real nursery be established. About 1,000,000 seedlings were grown in this nursery with great success and the trees were ready for planting in 1939 and 1940.

While all of this work was going on in West Ottawa County, State agricultural leaders had not been idle in working toward the preparation and passage of a suitable soil conservation districts law for Michigan. It is worthy of real note that while the State senate committee on conservation was considering a soil conservation districts bill, the West Ottawa County agent and the conservation committee for the county appeared before the State senate committee on conservation urging the members to sponsor a soil conservation bill. Later the same county people appeared before

the senate committee and urged them to favor enactment of the soil conservation districts bill which had been introduced into the legislature. The Michigan bill was enacted in the spring of 1937. The many local, State, and Federal influences leading toward the successful operation of this district and others is appreciated by the farmers and usually most gratefully so. For example, at each of the pre-district educational meetings sponsored by the Extension Service a member of the county conservation committee appeared on the program and discussed the need for a district.

The district started operations in the early fall of 1938. Less than 1 year later, all concerned agreed that it would be most appropriate if the district would take over the county nursery activities—the district had the appropriate powers and the suitable organization to make the nursery the going concern the county agent, the county board of supervisors and the local farmers had long wanted. On June 26, 1939, therefore, the district directors officially revised their district work plan and added the following provision: “It is the aim of the district, as the plan of work and operations actually develop, to establish and maintain transplants and seedbeds to facilitate handling of stock for the district, as well as the establishment of a district nursery, such nursery to be of sufficient size to produce approximately 1 million (1,000,000) seedlings, and requiring sufficient technical information as is necessary to produce said seedlings.” The county “turned over” its interest in a nursery to the district and has given its financial and other support to the district. The district nursery is established in a centralized place and the county nursery has since been discontinued.

The district has assisted owners and operators of 306 farms in preparing and starting to put into operation erosion control and soil conservation plans for their farms. These farms include 24,477 acres. An additional 200 farms are under consideration in some form, as their owners and operators have petitioned the district for assistance in putting into operation on their farms the appropriate phases of the district-wide program. Many other farmers are participating in the general educational and less intensive type of work of the district. The directors believe that were resources available to enlarge the staff of the Soil Conservation Service men assigned to the district, to enlarge the nursery, complete the details of surveys, etc., the number of petitions by farmers would jump quickly. The farmers in general realize that all farms in the district cannot be considered by the directors and their helpers at the same time and in the detail

necessary for the making of a worth-while and complete plan. Because of this understanding the directors have not been pushed for assistance.

Over 2,600,000 trees have been planted on approximately 18,000 acres. For this work, the district was able to supply about 50 percent of the labor through the facilities of a C. C. C. camp made available to assist the district by the Soil Conservation Service. The other 50 percent of the work was done by the farmers. In 1939, before C. C. C. assistance was available, the farmers planted 750,000 trees and shrubs.

In each instance the landowners and operators have entered into cooperative agreements with the district, agreeing to establish a practical erosion control program for their entire farm, and specific farm conservation plans for such programs are made as a basis for these agreements. Approximately 50 miles of 1-, 2-, 3-, and 4-row coniferous windbreaks have been established. Some 2,600,000 trees have been made available for this planting program at a low price: 1,400,000 through the district; 350,000 through purchase by landowners and operators from sources outside the district; 850,000 through grant by the Soil Conservation Service. In addition, a total of 200,000 shrubs for wildlife food and cover have been planted.

The farm seedbed program has been expanded by the district; 22 beds were established in 1939, and 69 in 1940. It is believed by the directors that some 10,000 trees may be produced from each bed. The county nursery, referred to earlier, supplied 200,000 seedlings which were sold by the district to cooperators and 800,000 seedlings which were transplanted into the district nursery. The district nursery, originally equipped with a seedbed capacity of 1,000,000 has been expanded; a second part was started this year, with a 2,000,000 capacity so that when in full production, if expectations are realized, the nursery will have an annual net production of 2 million trees.

The establishment of the district nursery and keeping it in operation has not been an easy matter for the directors. They were short of funds and what they had was mostly spent for the installation of the nursery. There was a need for weeding, lifting, transplanting, and other operations that required labor. Nevertheless, when great difficulties arose, the dominant will to succeed and the spirit of "finding a way" prevailed. The local sheriff was consulted with reference to labor assistance for the district from the men confined in the county jail. The source proved fruitful—166 days (8-hour days) of labor were given to the district. At another period when the district was destitute of labor and funds, the Olive Ladies

Club, a church organization, donated their services for helping carry on work in the nursery. This, plus other contributions, amounted to a total of 42 days of labor. The bulk of the work for operating the nursery came through the regular channels of hired labor, 540 days of this type being expended. Further evidence of interest in the district program is manifest in that the land on which the nursery is located was donated by one of the district directors, Frank Garbrecht. Mr. Garbrecht also gave team and tractor power, and tools needed in plowing and fitting the nursery. The cost to the district for installing the nursery was \$1,050.

The nursery operations have perhaps constituted one of the district's most important operations exclusive of the farm planning work. With 34,000 acres of active blow areas and 25,000 acres of potential blow areas within the district, it is easy to understand why the directors wish to move forward on a comprehensive tree-production and planting program. Since the landowners and operators are low on resources for "out-of-pocket" expenditures, it is essential that they obtain nursery stock at a very low cost. Furthermore, there is within the district a considerable area of publicly owned land such as tax delinquent State-owned lands, county-owned lands and others needing reforestation, and the district is making arrangements to lease appreciable areas in order to stabilize the erosion on them. In such a program the district needs its own planting stock.

Another important part of the program of the district involves the stabilization of erosion on cropland areas. A good crop rotation and cover crop program is laid out by the governing body of the district. The soils are somewhat acid and the addition of lime or marl is necessary to facilitate the vegetative program. The directors knew that marl was available in the district and pits were possible. They contracted with the owners of the supplies to allow them to take out marl; this was in turn sold to the farmers at cost plus transportation. A small additional charge of 10 cents per yard was added to cover general expenses of the district in this undertaking, and was paid by the cooperators when buying the marl. Some 6,000 cubic yards of marl have been supplied by the district to those cooperators needing it. Three marl pits are being operated by the district to carry on this worthwhile phase of their program, and to meet the total needs additional hundreds of cubic yards will be distributed. To initiate this work it was necessary for the district to borrow \$400 and the local banker was willing to assist in supplying these funds at a very reasonable rate of interest.

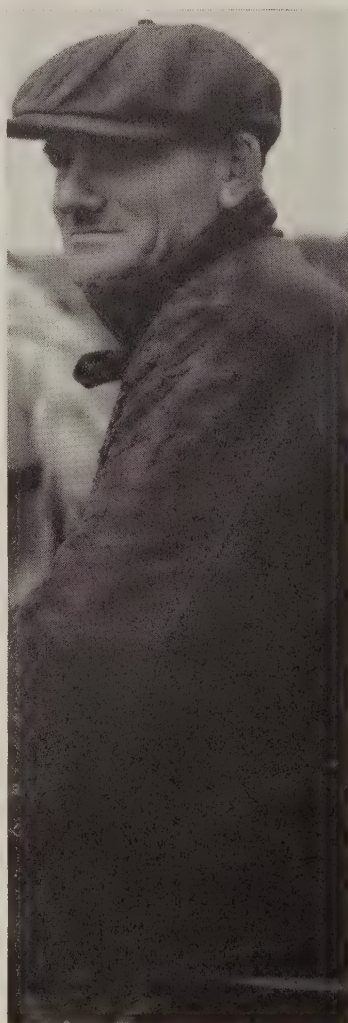
THE MUNSON CONSERVATION DISTRICT—AN EXAMPLE OF DEMOCRACY AT GRASS ROOTS

BY KENNETH S. DAVIS¹

EIGHTY years of hard farming have left their marks on the land of Henry County in northwestern Illinois. Gullies crease hundreds of fields. Topsoil is piled deep at the foot of most cultivated slopes; it is wearing thin up above, even though most of the slopes themselves are as yet ungullied. Soil productivity is quite obviously on the downgrade.

Not that Henry County is poverty stricken, or even on the verge of becoming so. Far from it. As a matter of fact, it is one of the richer Corn Belt counties, with a vast wealth of fertile soil still intact. The Henry County Farm Bureau, with 1,370 members (approximately half of the total number of farmers), is one of the leading bureau units of the State—and in Illinois the agricultural prosperity and progressiveness of a county usually can be measured by the strength of its farm bureau. But the fact remains that soil erosion is gnawing at the base of the county's farm wealth, and a growing number of local farmers are aware of it.

Out of this local awareness, or because of it, has emerged the Munson soil conservation district, organized by the farmers themselves under the terms of Illinois' conservation district law. The district, organized in January of 1940, takes in 240 farms comprising 34,782 acres in almost the exact center of Henry County. Through the district organization, conserva-



William Krantz, first farmer to sign a cooperative agreement with the district: "We'll all be doing this in a few years, so we may as well learn now to plant on the contour."

tion practices are being spread—not as rapidly as some of the farmer members would like, but with increasing momentum.

The farmers who direct the district are just beginning to glimpse the endless possibilities for profitable group enterprise in the new organization. They are just beginning to glimpse, likewise, the role the districts may be called upon to play with regard to agriculture in national defense, in post-war reconstruction, in the development of a sound national economy. But ideas are growing in their minds, which if properly nourished will bear rich fruit.

A farmer by the name of Gilbert Brown, for example, remarked to me recently as follows: "The district is still in the educational stage. At the present time we have 33 agreements with farmers, but that is not an accurate measure of farmer interest in the district work. The interest is there, and growing." Mr. Brown operates 310 acres near Geneseo, is chairman of the Munson district board of directors, a graduate of the University of Illinois, and an outstanding community leader.

There is a growing feeling also that the district is in fact a farmer's organization, and not in any sense an artificial set-up imposed upon local people to facilitate the distribution of Department of Agriculture programs. Brown commented on that fact, with approval: "It takes time, of course," he said. "But farmers in this community are taking hold in good shape. It is their program and they like it."

In Brown's opinion, the land-use capability maps constitute an important forward step in education for wise land use—this because farmers can understand the colored maps, whereas detailed soil survey maps are bound to remain "Greek" to most of them. After all, he pointed out, it is the use of land with which the farmer is concerned. Brown was even optimistic with regard to the possibility of farmers being trained to make their own land-use capability maps—after he had thought it over for a moment. At first he was doubtful of the practicability of the idea; then he recalled the rather complicated layouts that have been handled successfully in recent years by farmers serving as A. A. A. committeemen: "If farmers can do that, maybe they could make their maps—their own maps," he said. "I'm inclined to think they could, with proper training."

(Continued on p. 222)

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Hogs and erosion versus hogs and clover—contrasts found in the Munson soil conservation district. The view of “pigs in clover” is on the Gilbert Brown farm. Mr. Brown is chairman of the district directors. He is growing less corn and more legume hay, as part of his conservation plan.

The lack of soils maps is one of the things that slowed down district agreement sign-ups during the past year, and Brown could see that the mapping problem is bound to become increasingly serious as the district idea is accelerated throughout the country. "Obviously, something will have to be done," he said. "I believe it is up to us, the farmers, to do it, or help do it."

John R. Johnson, who owns 348 acres within the district and 120 acres outside, is another member of the Munson district's board of directors. He is pleased with the way the district idea is taking hold, but he would like to see more cooperators.

"We'll have more next spring," he said. "I look for a spurt in sign-ups, along about oats-planting time."

Weather conditions during the season just past are at least partly responsible for the present slight lag in district sign-up, Johnson thinks. It was a dry season, with no really heavy washing rains, so that neither soil erosion nor the effectiveness of control measures showed up in the fields. Next year is likely to tell a different story, although, generally speaking, drought conditions are becoming more and more frequent in Henry County. In Johnson's opinion, it is the way the land is being used that is responsible for the condition. To make greater use of the soil as a reservoir for water is one of the chief aims of the district program.

"The water table is down several feet," Johnson said. "I had to lower my well last year, and several of my neighbors have had to do the same thing. We've been letting the water run off the land, instead of soak in."

More grass, less corn; contour tillage instead of straight rows; more trees on steep slopes; terraces—all these are raintraps, by which rain may be harnessed and put to work growing crops. They are devices for raising the water table. "It will rise once we get the land in the district control program," declared Johnson. He knows that the district is now in the educational phase, but he doesn't think it will be difficult to "sell" the erosion control idea to his neighbors. Demonstrations will do it, and each cooperator's farm is, of course, a practical demonstration. "It can be proved that soil conservation pays out in dollars and cents," the director asserted, and cited his own personal experience as evidence.

Several years ago, Johnson bought a 160-acre farm within what now constitute the boundaries of the Munson district. He paid \$22 an acre for it. In cooperation with a Soil Conservation Service C. C. C. camp at Galva, Ill., he worked out an erosion control



John R. Johnson, a director of the Munson soil conservation district, found that soil-saving practices doubled the value of his 160-acre farm.

program for the farm including contour tillage, a revision of cropping systems, complete change of field shapes and consequently of field fences, and soil treatments with lime and phosphate fertilizer.

"Putting that program on the place cost me about \$670—\$250 for lime, \$100 for phosphate, and \$320 for new fencing and removal of old lines," Johnson reported.

In other words, the program cost about \$4.20 an acre—and it boosted the value of the farm at least 100 percent, by Johnson's own conservative estimate. He said that he would "think a long time" before he accepted an offer of \$45 an acre for this farm—a farm which, 3 years ago, was worth barely \$22 per acre. Conservation planning alone has made the difference!

"Certainly it should not be hard to sell such a proposition," Director Johnson said. He is anxious to have the district carry out individual practice demonstrations as part of the district program. Soil treatment demonstrations would be especially valuable in the Munson district, he thinks, and he is already planning such work—has selected the field and has a well-developed procedure in mind. The board will consider the plan at an early meeting.

But with regard to the larger significance of the district program—the role which local districts might play in an agricultural economy changed by the impact of war and shifting trade relations—neither Johnson nor Brown has as yet a thoroughly developed understanding. Johnson, to be sure, has carefully considered the possibility of imposing land-use regulations

within the district and is not opposed to the idea in principle, provided it is carried out democratically (as it necessarily would be, under the terms of the district law) and is used only as a last resort. Both men are agreed that such regulations, if they become absolutely necessary, should be imposed by local people through local organizations rather than by Federal or State officials far removed from the land.

The need for *planning* agriculture—to absorb the shocks which either a greatly reduced or greatly expanded export trade may bring to our farm economy in the next few years—is apparent to both men. They have an idea that the districts might play an important part in making and applying those plans; it is but the germ of an idea, really, but the fact of its presence is significant enough.

It is significant because, ultimately, the future of American agriculture must be determined at the grass roots and by the men on the ground if our farm problem, in its growing complexity, is to be solved according to the democratic ideal. Every evidence of mental apathy on the part of farmers with regard to their economic and social problems is one more danger—and every evidence of a growing social awareness is a reason for hope. Evidence of hope in the minds of such men as John Johnson and Gilbert



The owner of this land recently paid \$30 an acre for it. The upper part of the field is abandoned—ruined by erosion. The topsoil stripped from the sloping field has been piled deep on the bottomland below, where corn made 60 bushels per acre last year.

Brown and many others like them, is vindication enough, were there no other, of our democratic ideal of government, that *the government is the people*.

The Montesano-Elma-Oakville Soil Conservation District in western Washington is doing an excellent job of bank protection on the Wynoochee River. The eroding bank is covered about 2 feet thick with a mat of spruce and hemlock boughs held in place by poles wired together and anchored to blocks of concrete deeply set below the mat. A long and compact floating bundle of alder, maple, and willow brush about 18 inches in diameter, known as a facine, is anchored with cables along the bank to reduce the cutting action of the river.

Twenty-one men of camp C. C. C.-S. C. S.-12 at Montesano completed 500 feet of this work in 13 days. Grays Harbor County has been supplying \$500 per month to provide material for doing such work in this 300,000-acre district. The Soil Conservation Service is furnishing technical help and supervision principally. Such cooperative work stops the Wynoochee and other rivers from eating away the bottomland fields that are vital to successful farming in this area, and protects highways from being washed out.

Eleven soil conservation districts in Georgia are receiving assistance from the Division of Wildlife of the State of Georgia under a memorandum of understanding between the individual districts and that State agency. The help rendered consists of such items as the following: Assistance in conducting survey studies, field tests, etc., of a biological nature; seed and plants for, and aid in, establishing seed source plots; participation along with other agencies in carrying out the wildlife phases of an educational program, especially with sportsmen and civic groups. All such assistance is provided in accordance with the respective district's program, work plan and farm plans of the district and individual farmers.

A similar cooperative arrangement has been entered into between the Southside Soil Conservation District in Virginia and the Virginia Commission of Game and Inland Fisheries. The same kind of cooperation is being favorably considered by the Commission in regard to other districts in Virginia. The indications are that similar cooperative work will soon be effective in Mississippi and a few other States.

THE LAND COMES FIRST

By WALTER W. JOHN¹



Lester Hass has faith in the land, and in his ability to make a good living from it.

LESTER Hass practices the idea of putting first things first.

When Dave Davidson and I stopped to interview him on a cold day last November he and his dad were digging a trench so that he could pipe water from his cistern into the barn. He might have done that work last summer when the weather was more pleasant. But during those pleasant summer days, young Hass was very busy making sure that his land was protected against erosion.

As he expressed it, "I believe in taking care of the land first and fixing up the buildings as I can get to them. If we don't protect the land, we are not going to need the buildings."

Lester Hass is a young farmer in Winona County, Minn. He has faith in the land and in his ability to make a good living on it—that is why he purchased the 169-acre farm and took his bride there to build a home. George Hass believes in his son's ability; he helped him make the deal for the adjoining farm. Together they had put into effect a complete soil conservation plan on the "home" farm and they knew what results to expect from such practices.

On October 25, 1939, Lester had walked into the office of Dave Davidson, conservationist of the Burns-Homer-Pleasant Soil Conservation District, and said, "I bought a farm today. I want you to come out and help me set up conservation on it."

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Dave went, helped him stake out two or three contour lines, advised him on a rotation and field plan, and encouraged him to go ahead from there. He did go ahead with it, faster than anyone thought he could. Before the ground froze, he had all of the 60 acres of cropland plowed on the contour—the exact contour, for he was particular about having the rows level. In the spring he planted corn, oats, and alfalfa in strips where lime had been applied at the rate of 2 tons to the acre.

He fenced about 50 acres of woodland that guarded some steep slopes. All fences around the cultivated fields had been removed before the fall plowing, and last summer they were rebuilt on the contour. Three pasture fields of about 15 acres each were laid out and pastured alternately a week at a time with his herd of 10 Holsteins. His young stock was kept in a valley pasture where they had access to spring water. Gullies had been plowed in and seeded and a good sod established in all waterways.

Within the year, Lester Hass had applied on his farm a complete conservation program, most of which he had planned without help. It was then that he had time to do some work on the buildings.

"The whole place was run down," he told us. "Renters had plowed up and down hill so long that the land was getting in bad shape. The buildings aren't good either, but I can fix them up." Apparently a little paint and repair work will put the buildings in good condition for they seem to be sturdily built.

Mrs. Hass has redecorated their home comfortably and attractively. Under the R. E. A. program they have wired both house and barn. Lester wants to remodel the barn before long so that it will accommodate 30 dairy cows, and, as soon as he can afford it, he plans to install milking machines to lighten the work load.

What do the two Hass men think of conservation farming? George Hass looked up from trench digging long enough to say, "I think farmers are touched in the head if they don't do it." In Lester's opinion, the Government ought to force farmers to stop plowing up and down hill. "On the other hand," he reflected, "these soil conservation districts are doing a real job, and farmers will keep up that kind of work because of its voluntary aspects. Some are slow to take to new ideas, but they soon see that this work pays. Soil



Aerial view of the 220-acre farm of George Hass, near Winona, Minn. After helping his father protect this "home" farm, Lester Hass bought an adjoining farm and put a complete conservation program on it in one year.

conservation is the biggest thing the Government has done for farmers."

Young Hass is number 70 on the local draft board list. He is ready to do his part in the defense program and believes he can help greatly by taking care of his soil. "We must have guns and planes," he said, "but we can't do anything without the soil."

The topography of the Hass farm is representative of hundreds of farms along the "breaks" of the Mississippi River. The cropland lies mainly along a ridge and grades steeply into V-shaped valleys. The land-use classes now fit closely the varying degrees of slope. Lester was quick to understand the importance of colored land-use maps and he has carefully followed the maps in putting the information to use on his own farm. "When you farm up and down hill you have crops running through two or three different classes of land," he explained. "By putting the rows on the level, each crop will fall nearly in one class. These contour rows hold more moisture on the fields." Father and son have been active in group planning meetings conducted by district supervisors and technicians. "A farmer at one of these meetings told us we were crazy to plant crooked rows, but we soon put 'kinks' in his argument," George Hass remarked to us.

George and Lester Hass first saw strip cropping and contour farming when they were visiting friends in Iowa about 4 years ago. They have been trying to

protect their land against erosion ever since that visit. Lester's plan is to build up his pastures, grow considerable amounts of alfalfa, and feed all crops to his dairy herd. "Alfalfa and pasture are my best-paying crops," he said. "They keep working for me without much work on my part or much cost. Corn and hogs take too much out of the soil. I'm going to stick to milk cows." He is now getting about \$7 a month per cow from cream sales, and he feeds the skimmed milk to calves. He hopes to increase that income to \$9 a month as he builds up his herd by "weeding out the ones that don't pay."

Contour farming, strip cropping, and a 5-year rotation are holding soil and moisture on the cropland which stretches out along a narrow ridge; good pastures guard the "in-between" slopes; timber prevents serious erosion on the steeper slopes below. Buildings and fences receive attention, all in their time, on the Hass farm.

Members of the Lions Club at Lineville, Ala., in the Piedmont Soil Conservation District, purchased 100 pounds of kudzu seed and distributed it in 5-pound lots to 20 4-H Club members. Fertilizer was also supplied for these plantings. This should result in the production of from 200,000 to 400,000 kudzu plants in the Lineville area and 400 to 800 acres of new kudzu plantings should be established.

WHY NEW HAMPSHIRE NEEDS A SOIL CONSERVATION DISTRICTS LAW

BY J. L. HADDOCK, K. E. BARRACLOUGH, AND FORD S. PRINCE ¹

WE, in New Hampshire, have recognized many farm problems in the past and have worked toward their solution, and through it all we have boasted with considerable pride that soil erosion was not a problem here. But, little by little, especially throughout recent years, those people who are alive to farm problems have come to realize that soil conservation is not limited to preventing dust storms and gullies, but that its ultimate objective is much broader and more comprehensive in that its purpose is the maintenance of permanent productivity of the land while the land is being used for maximum economic production. This implies the utilization of land according to its best capability, and includes land-use planning directed toward better cropping and woodland-management practices. With this understanding of soil-conservation objectives, it is not difficult to see the relationship of many of the State's farm problems to soil conservation practices.

New Hampshire forests and woodlands have become increasingly less productive. For many years clear cutting and stripping have been practiced with no thought of reproduction. There were heavy timber losses during the hurricane of 1938; and now a new problem is before us in the increased demand and price for pulpwood and lumber, or, in other words, the temptation to cut the young growing stock. Some of the men who represent the lumbermen, and those interested in the social and economic welfare of the people of the State, have arrived at a place in their thinking where they are discussing the need for ways of securing woodland-management regulations in order to prevent injurious cutting practices and to increase the productivity of the private and commercial woodlands and forests.

New Hampshire has a total area of 5,779,840 acres, and over 80 percent of this land is wooded. This makes forest management the major land-use problem particularly in view of the fact that the timber resources are so badly depleted that it has become highly impractical for private capital to retain many of the tracts. This situation has been accentuated as a result of the hurricane of 1938.

Broadly speaking, there are but two types of forest

land in New Hampshire, areas that have been once or several times culled but never cleared, and lands that have reverted to woodlands after a century or more of use as farms. Since 1900, both types of forest have been logged by clear cutting, leaving a heavy debris of slash. In some sections fire has further depleted the soil resources. The immediate effect of this treatment has been a steady falling off in composition of new timber crops after cutting. The supply of seed-bearing trees of satisfactory age and species has become less and less, while light-seeded inferior species, such as grey birch, popple, and pin cherry, which are better adapted to survival on exposed areas, have constantly increased. Thus, even where sufficient desirable reproduction still is maintained, as in older mixed stands such as culled remnants of virgin forests, either the seeding of weed species or the excessive development of hardwood stump sprouts steadily pushes out the desirable elements of the forest.

The situation relative to the 747,434 acres of open land, or the 12 percent of the total land area that is used for pasture lands and the growing of crops, is somewhat different from that of the woodlands. Progressive commercial farmers have kept their open lands in a fair state of production, although many of them have neglected their pastures. Unfortunately, the number of commercial farms is a small part of the total 17,000 farms of the State. In many sections, especially in the hill areas, farm lands are still reverting to woods rather rapidly. Thousands of acres of hay lands have "run out" as the demand for hay has diminished. Many abandoned farms have become property of summer people who are not dependent upon the soil for a livelihood. Generally, these people do not work the soil, although a fairly large number do farm on a commercial scale and give considerable care to building up the soil. Recently, woodland management has interested these people.

The floods of 1927 and 1936 directed our attention toward the more spectacular, though possibly not the most important, phase of soil erosion in New Hampshire. During these floods, many acres of valuable farm lands were torn from river banks of some farms and the infertile, sandy fractions of the soils deposited on formerly fertile and productive terraces of other farms. Groups of farmers, alarmed by the loss of large segments of their small acreages, and almost

¹ The authors are extension agronomist and extension forester of the New Hampshire Extension Service, and professor of agronomy of the University of New Hampshire, Durham, N. H., respectively.

helpless to cope with so formidable a foe, appealed to the State and Federal agencies for assistance. Invariably these groups were told, "Your cause is just but we can do nothing for you." It may not be out of place to outline briefly the experiences of one farmer group in their attempt to secure assistance.

The county agent was asked to help them to locate some organization that would render assistance. The W. P. A. reported that some responsible governmental unit must sponsor the project and assume liability for all damage which might arise. This was not feasible since the farmers affected belonged to several towns and made up a small minority in each. The matter was next referred to the Governor through representatives of the group. The Governor authorized an investigation and the investigators recognized the importance of the situation and promised to bring the matter to the attention of the Governor and council. Nothing was heard from their action. The Soil Conservation Service was asked to investigate and did. It was acknowledged that conditions in this area were similar to those in the Winooski Valley in Vermont, and justified a demonstration project. Since the Winooski project was established as a demonstration and funds were not available for work in other river valleys, it was recognized that protective measures could not be undertaken until after the enactment of a State districts law empowering the farmers affected to set up a soil conservation district of their own.

Comprehensive surveys of upland and riverbank erosion, in New Hampshire, have not been made, although both are now recognized as important problems. We can say that the compact soil types (those with hardpan) show slight erosion on slopes of 0 to 5 percent, moderate erosion on slopes of 5 to 10 percent, and severe erosion on slopes of 10 to 15 percent. The best soils are cultivated most frequently and hence it is these best soils that suffer most severely from sheet and gully erosion. It is estimated that, in the Merrimac watershed alone, approximately 150,000 acres show slight sheet erosion with occasional gullies and about 18,000 acres show moderate sheet erosion. From 5 to 10 percent of the riverbanks of the Connecticut, Merrimac, and Saco show serious erosion.

To preserve the present farms as working units, we can scarcely afford to lose, by erosion or by general neglect, lands now comprising parts of the farming units. Soil conserving practices are needed to conserve the soil, prevent destructive floods, and stabilize farming operations in the fertile river-valley lands.

Farmers on the hill lands, who grow potatoes and other cultivated crops intensively, are already becoming very much aware of erosion, and a few have adopted contour farming practices, while in the more serious instances terraces and diversion ditches have been constructed to control run-off and erosion. Terrace and diversion ditch construction requires the services of a trained engineer, and any phase of contour farming can be established more effectually with the help of skilled technicians. The average farmer cannot afford to employ help of this sort, but the passage of the soil conservation districts law, to be followed by the organization and operation of districts in interested localities, would open the door to cooperating agencies through which adequate planning and technical help would be emphasized.

While past and present educational efforts in the State have been a factor in retarding the exploitation of soil resources and have been responsible for increased crop yields on many commercial farms, it has become more and more apparent that a stable economy is dependent upon an arrangement by which all producing lands will produce resources of one kind or another. Tiny islands of high-yielding crop and pasture lands cannot continue indefinitely to support vast areas that are not contributing to the income of the rural areas. Depleted forest lands and idle open areas bring us vacant wood-using plants, unemployment, stranded communities, floods, erosion, human suffering, and the gradual lessening of individual initiative. The situation becomes a vicious downward spiral.

Even the most intensive educational program cannot correct the land-use situation in rural communities, with its trend toward a laissez-faire attitude. Federal and State assistance, so managed as to stimulate people to take leadership in solving these land-use problems, is needed. The tendency to siphon the wealth of rural areas to the large centers of population makes the situation more critical; with such a type of economy, the rural communities must look to the larger units of government for assistance in the solution of their problems.

The land problem is so serious in New Hampshire that people should be given an opportunity to devise means for shifting from a policy of exploitation of soil resources to a program of conserving and developing the resources of the soil. Such a program involves giving landowners every possible practical assistance in accomplishing the objective, such as technical assistance, field demonstrations, and even subsidy in

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Corn in river bottoms was badly hit in the August 1940 flood in western North Carolina.

A ONCE-IN-A-HUNDRED-YEARS RAIN

BY E. B. GARRETT ¹

FARMERS cooperating with soil conservation districts in North Carolina watersheds report that in August of 1940 they were given a striking demonstration of the value during flood period of crop rotation, strip cropping, improved pastures, properly constructed terraces, and water disposal systems on their farms. The floods that swept across a large part of the State, in the wake of the Florida hurricane, set new records of destruction as swirling waters of swollen streams spread out over fertile valleys, washed out bridges, inundated manufacturing plants and marooned cities and towns, causing millions of dollars of property damage and leaving hundreds homeless.

In many sections the rainfall that preceded the disastrous flood broke all records for intensity and amount. Beginning on August 11, rains of considerable intensity fell for 2 days over a large area, saturating the ground and sending many small streams out of their banks. The water-soaked ground and already overburdened streams were unable to cope with larger volumes of water from the torrential downpours that followed on August 13, and 14.

Weather Bureau reports from a C. C. C. camp gage

at Buck Creek, 13 miles northwest of Marion, N. C., show that 15.8 inches of rain fell during the 4 days, with 9.45 inches in 24 hours after the ground had been saturated for 2 days. At Laurel Springs, 14.68 inches fell during a 5-day period with a peak of 10 inches in 24 hours. C. C. C. Camp SCS-24, at Forest City, reported 10.58 inches during a 6-day period beginning August 11, and similar reports were received from many other sections.

Heavy rains fell throughout a period of 9 days according to a special report on this storm by the Weather Bureau cooperating with the War Department and various agencies of the Department of Agriculture. Most significant is the blunt report from the observer at Elkhville, N. C.: "Record after 6:15 a. m. of the 13th washed away with the gage during the night of 13th-14th."

As the flood waters rushed down through the watersheds of the Yadkin, the Roanoke, the Catawba, the Cape Fear, the Tar, and the Neuse Rivers they fanned out over fertile farm lands and highly industrialized areas in the valleys. The waters inundated many manufacturing plants, washed out bridges, destroyed highways, flooded homes, and caused untold property losses. The Regional Flood Control

¹ State coordinator, North Carolina, Southeastern Region, Soil Conservation Service, Raleigh, N. C.

Section reports that damages in the upper Yadkin and Roanoke Basins reached greater proportions than during the great flood of 1916.

North Wilkesboro, a town of 4,000 population, lying 125 miles northeast of Asheville, was one of the worst hit by the flood. It was completely cut off from the world when the Yadkin River, rising to unprecedented heights, disrupted light, water, and telephone facilities. With water everywhere, residents of the town stood helplessly as two large industrial plants encircled by the flood burned to the water line. Mayor R. T. McNeil estimated that the damages in North Wilkesboro alone would amount to \$2,000,000 and in Wilkes County as a whole to \$10,000,000.

The city of Asheville was forced to draw on an emergency reservoir when flood waters washed out all mains from the city's water supply. The Southern Railway was forced to reroute trains at Asheville, owing to a landslide at the mouth of a tunnel near Ridgecrest, and two persons were crushed to death by a landslide at Boone.

As similar flood waters spread out over Virginia, South Carolina, and Tennessee, thousands of acres of bottomland corn were covered and made unfit for use. Watermelons that floated out of farmers fields were "fished" from swollen streams by crowds that gathered on bridges to watch the swirling waters, and even pigs and other livestock were rescued as prize catches.

During the unprecedented rains in the watersheds above, tons of fertile soil were washed from unprotected fields; but soil conservation district cooperators, who had developed on their farms various practices designed specifically to hold and improve the soil, reported quite the reverse regarding some of their protected fields. Rains of such intensity and duration are very unusual. In fact, in many sections of North Carolina the rainfall was classified as a "hundred-years rain." It is the intense rains, however, that farmers must guard against, and it is of considerable interest to know how farmland protected by a sound conservation program withstood the intense and continued rainfall of this 9-day period. The answer, as given by the farmers who are cooperating with soil conservation districts, is that a sound conservation program will protect farmland against even a "hundred-years rain."

G. M. Alexander, a cooperator of the Tri-Creek Soil Conservation District in Wilkes County, where the heaviest rain in the State fell in the shortest period of time, with a 6-inch rainfall between 6 p. m. and midnight on August 13, reported that although he lost 15 acres of bottomland corn in the flood that followed the rain, yet very little damage was done to an upland

corn field that was strip cropped with corn and lespedeza. "If the 9-acre field had been in corn without the strips of lespedeza, the loss of soil would have been very heavy," said Mr. Alexander.

Charles Beck, cooperating with the Middle Yadkin district in Davie County, has a small farm of 30 acres under district agreement. All of his land was terraced; he was carrying out systematic rotations and was working all his land on the contour. After seeing how the protective measures withstood the intense rain he remarked that he "would not take a thousand dollars for the soil conservation plan on the farm." He reported in detail as follows: "I found no damage caused by the rains. A 700-foot grassed waterway carried the water from terraces in one field without any damage to the field or waterway. Before the plan was worked out for my farm, I did not have any terraces or rotations and my land was washing away even during ordinary rains. I don't like to think of what would have happened to my farm if it had been in that condition when these rains came. Land next to my farm, where no conservation practices were being used, was badly damaged by the rains."

Clarence Everhart, who has been a cooperator in the old Lexington demonstration project for 5 years, had a well-established conservation program on his farm, with systematic strip rotations, properly constructed terraces, and other soil-conserving practices. A rain gage on the farm registered 3.6 inches during the 11-hour period from 8 o'clock in the evening of August 13 to 7 o'clock the next morning.

"While almost no damage was done on my farm," Mr. Everhart commented, "on a neighbor's farm where there were no conservation practices, recently plowed land was washed away in places to the depth of plowing. Now I can sleep at night no matter how hard it rains, because I know I will not find my land washed away when I get up the next morning."

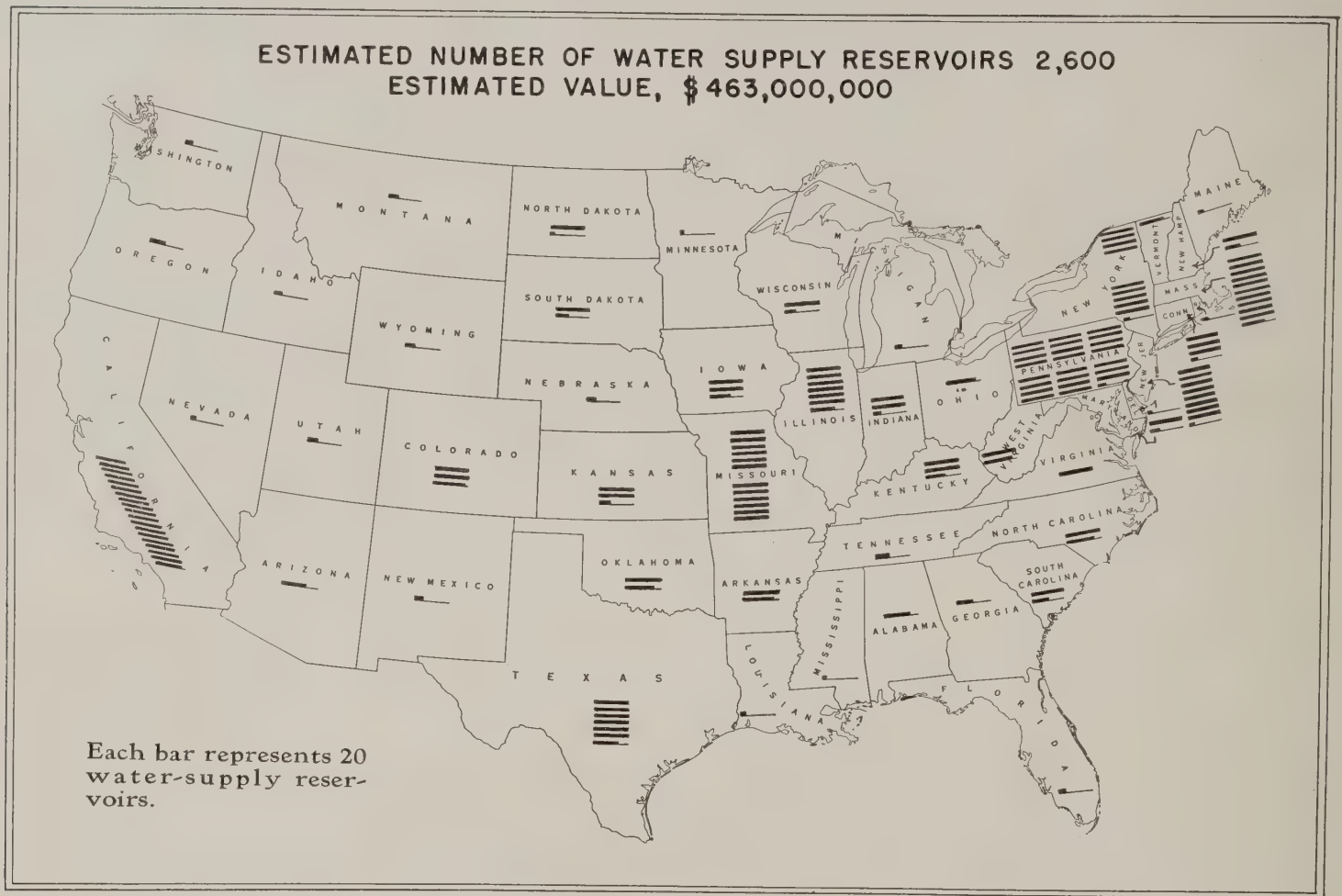
From the western part of the State, in Polk County in the Broad River district, John Arlidge reports that on properly terraced fields on his farm, where he is carrying out a 4-year strip rotation of cotton, small grain, and lespedeza, he "did not lose a bushel of soil" during the intense rains.

In Vance County, in the eastern part of the State, J. H. Brodie, one of the supervisors of the Tar River district, made the following remarks: "At first my tenants were doubtful of the value of establishing soil-conservation practices, but they have found that the hay crops they are producing from the meadow

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PROTECTING RESERVOIR WATERSHEDS THROUGH THE DISTRICTS PROGRAM

BY CARL B. BROWN¹



STORAGE reservoirs for municipal and industrial water supply are among the most valuable water-utilization developments in the United States. More than 2,600 dams have been constructed to impound water-supply reservoirs, at a cost of more than \$463,000,000 exclusive of appurtenant waterworks and distribution lines. Between 15 and 20 percent of the entire population of the country obtains its domestic water from these sources.

Measures being taken today by many of our great cities to protect water-supply sources against sabotage, emphasize their vital importance to the national defense program, indeed to our whole industrial and commercial life. In the Engineering News-Record for July 18, 1940, this statement appears: "Mobilization of industry for defense puts a new responsibility on municipal water officials. Probably no resource is more vital in times such as these—nor more vulnerable—than water service. What measures should be taken, therefore, to safeguard this essential service from sabotage?"

Sabotage by foreign agents in the event of war, while perhaps in places a more imminent hazard, will almost certainly be less widespread and less sure in its ultimate effects than another menace which we ourselves create. This is the menace of lost storage capacity resulting from silting caused largely by accelerated soil erosion. "What measures should be taken, therefore, to safeguard this essential service from . . . " silting?

The answer, as supplied by rapidly accumulating evidence, is adequate watershed protection and erosion control. The means for achieving this objective on a widespread scale are now developing for the first time through the soil conservation districts. Heretofore the adequate protection of reservoir watersheds generally was impossible without the purchase of entire drainage areas by the reservoir owners, and this could be done only in occasional instances. Today, however, the districts are providing a legal

¹ Head, reservoir section, sedimentation division, Soil Conservation Service, Washington, D. C.

medium for cooperative effort of urban and corporate interests with agricultural interests in erosion control for the mutually beneficial purpose of conserving farm and range lands and maintaining reservoir storage capacities.

During the last 6 years the Soil Conservation Service has collected sufficient data through reservoir surveys to indicate the magnitude of the reservoir silting problem. Up to August 1, 1940, detailed surveys of 96 reservoirs and reconnaissance surveys of 252 others had been completed. With records on 57 detailed and 16 reconnaissance surveys by other agencies, we now have at hand usable data for 421 reservoirs of all types, distributed through 34 States, out of a total of more than 10,000 in the Nation. Of these 421 reservoirs, 151 are used primarily for water supply.

Assuming that the useful life of the average reservoir is ended when 80 percent of its original capacity is gone, and projecting into the future a uniform silting rate based on past performance, it is possible to analyze the data from the 151 water-supply reservoirs and determine the following facts pointing out the seriousness of the silting problem: 21 percent will have a useful life of less than 50 years as a result of silting; another 25 percent will be lost in 50 to 100 years; and only 54 percent will provide enough storage to suffice for present requirements (not the estimated future needs) 100 years hence.²

In a recent study of 22 water-supply reservoirs in the Piedmont of North Carolina, Garin and Forster³ estimated the annual capital loss by silting at \$32,000. An unpublished report by Garin, covering 17 water-supply reservoirs in the Trinity watershed in Texas, has shown an annual sedimentation damage of more than \$100,000. These figures are convincing evidence that the total annual damage over the Nation amounts to millions, possibly tens of millions of dollars.

The measures that can be taken "to safeguard this essential service"—water supply—are fairly well understood, and the means for their execution is rapidly developing as the soil conservation districts program expands. Here and there a beginning is already being made. It is interesting to note the widely separated localities of some of these beginnings.

² The assumption of 80 percent of the original capacity may be too conservative. An investigation by A. N. Garin, economic research division, of 17 water supply reservoirs in the Trinity watershed, Tex., indicated a range from 38 to 85 percent and an average of 60 percent. If it were assumed that 60 percent of the original capacity would terminate the useful life of the average reservoir, then 32 percent of the Nation's water-supply reservoirs would be useless in less than 50 years and another 22 percent in less than 100 years.

³ Garin, A. N., and G. W. Forster: Effect of Soil Erosion on Costs of Public Water Supply in the North Carolina Piedmont. U. S. Soil Conservation Service, SCS-EC-1, 106 pp., illus. 1940.

In the Southeastern Region, the Project Plans Division of the Soil Conservation Service has compiled a list of all reservoirs in existing soil conservation districts, and the Sedimentation Division has assisted in making a record of sedimentation data. These facts have been called to the attention of district conservationists, and requests are now coming in for assistance in studying the needs of various cities for protection of water-supply sources.

In the Upper Mississippi Region, the Chamber of Commerce of Decatur, Ill., together with other business and professional organizations concerned about silting in the municipal Lake Decatur, have given active support to a petition by landowners of Macon County to organize a district to include part of the Lake Decatur watershed.

In the Pacific Southwest a cooperative agreement has been signed by the East Bay Municipal Utilities District of Oakland, Calif., and the Soil Conservation Service to carry out an erosion-control program on the watersheds of Upper San Leandro and San Pablo Reservoirs, located in the hills east of Berkeley. Already considerable tree planting has been done and other forms of conservation work are being carried out.

Widespread interest has been manifest among municipal, water company, and industrial officials in all sections of the country in ways and means of protecting reservoir watersheds. Probably because of the existence of so many other serious erosion problems, officials of the districts and of the Soil Conservation Service have not as yet given close enough thought and attention to the possibilities for cooperation with these interests. For this reason and because of the importance of such cooperation, I am pointing out in the following paragraphs some outstanding factors that might well be weighed and considered by the district governing bodies in formulating their district policies:

The aggregate acreage in reservoir watersheds usually is only a small part of the total acreage within the district. Farmers, road commissions, and other interests may be expected to carry out as much conservation work on these areas as in other parts of the district. Therefore, if those municipalities and corporations concerned with water-supply reservoirs should participate in the conservation program, as they may under the district laws, *more complete* erosion control could be achieved on the reservoir watersheds than in most other parts of the district. Hence, if reservoir watersheds were given early priority for planning and treatment in the districts program, they would provide compact demonstration areas that

would serve not only to accelerate the adoption of conservation practices by agricultural interests but also to encourage the active support of 15 to 20 percent of the country's population living in towns and cities. Such demonstrations would bring to the towns and cities an understanding of their direct "stake" in, and financial benefit by, the protection of their reservoir watersheds. Surely such support is an objective worth striving for.

A district policy based on the considerations discussed above will require thorough and reliable planning in order that concrete benefits can be shown 5 or 10 years hence through measured reduction in the rate of silting. This planning should include appropriate physical and economic surveys of sedimentation damage, quantitative determination of sediment sources, and development of control measures which without fail will hold back the erosional debris from the reservoir.

The steps in translating such a policy into practice might follow a general pattern, the steps of which are outlined below:

1. The soil conservation districts, with the assistance of the district conservationists, should obtain records of all municipal and industrial surface water-supply sources within their district areas, whether from impounding reservoirs or not. (Form SCS-327, National Reservoir Inventory, which can be obtained through the Sedimentation Division, Soil Conservation Service, Washington, D. C., would be a convenient form to use in recording this information. If there is no reservoir, the sections pertaining to the dam and reservoir could be omitted.)

2. If copies of these records were submitted to the Regional Project Plans Division, the information would permit consideration of arrangements for appropriate sedimentation and economic studies to determine the amount and rate of annual damage and the extent to which the water-supply interests could afford to cooperate for protection of their watersheds.

3. Where it appears that substantial cooperation is justified, the Project Plans Division and the Physical Surveys Division might then develop plans for quantitative measurement of sediment sources in the watersheds. (A study of survey technique is now being made on a sample watershed in the Southeastern Region by the Physical Surveys Division in cooperation with the Sedimentation Division.)

4. If the problem warrants, the district governing body might insist that farm conservation plans be developed to show not only what the farmer *can* and *will* do, but also what *should* be done on every acre

of the watershed to achieve the greatest possible reduction in the amount of sediment reaching the reservoir.

5. The water-supply interests should be approached with a definite plan for their cooperation in providing the erosion control measures required for reservoir protection over and above that which the farmer can and will undertake in his own interest. Types of control in which the cooperation of water-supply interests will be particularly useful and beneficial may be enumerated as follows: (1) Planting of gullied slopes, and structural gully control; (2) streambank erosion control and improvement of larger or inter-farm waterways; (3) road erosion control; (4) control of erosion from industrial and mining waste dumps and other nonagricultural sediment sources in watersheds where such conditions exist. Cooperation in these four erosion control measures is especially valuable not only because such work is often outside the scope and means of the individual farmer and other interests, but also because direct reservoir protection can result in the greatest reduction of sediment load.

The time for developing this cooperation of land owners and watershed users who have riparian rights is *now*—in the formative stage of the district's program. Landowners should encourage the participation of water-supply interests for a more complete conservation program, and reservoir owners should lend support to the formation and maintenance of districts as a legal medium for achieving better watershed protection.

A DISTRICT SAVES WATER

(Continued from p. 213)

Mr. Reid is very proud of the groves of trees around his chicken houses and farm home. He thinks small groves ought to be planted throughout the county wherever water can be diverted to the tree sites to assist them in making normal growth. The Central Curry District recently entered into an agreement with the State highway department whereby the two organizations will cooperate in planting trees along county highways.

Mr. Reid is a public-spirited type of man. He has raised and educated a large family. All but the youngest of his seven children have finished high school. Most of them have gone to college. Mr. Reid states that he never expects to get rich but has decided to try living instead of trying to make money. He and two grown boys farm the 1,100 acres that they operate. One boy is being called to the army soon.

IT CAN BE DONE

BY TOM DALE ¹

THE Dust Bowl has been practically chased out of Baca County, Colo. From 1935 to 1938 this county, one of the largest in the Southern Great Plains, was "infamous" as having more "wild" blow land than any other in the Nation.

Timely rains that came in the fall of 1938 and the springs of 1939 and 1940 have helped, but the rains were not more favorable in this county than in many neighboring ones that continue to blow almost as severely as in 1935 and 1936. The principal reason why the Dust Bowl is fading out of Baca County is that the people have put forth a concerted effort to drive the unwelcome guest from their midst. They, the farmers and landowners, have used the soil conservation districts as a means of establishing cover on the blow land of their county.

Two districts were created in Baca County in 1938. (Districts are named soil erosion districts in Colorado under provisions of the State law.) The Western Baca County Soil Erosion District sprawls over approximately half the county and covers about 850,000 acres, while the Southeastern Baca Soil Erosion District covers some 400,000 acres. Of course, these districts have had assistance in whipping the Dust Bowl. The A. A. A., the Farm Security Administration, the Soil Conservation Service, the State extension service, and various other agencies have helped them. But the important thing is that these districts are local governmental units controlled and operated by local farmers and landowners, through which Federal and State agencies can work on a unified program.

During the 6 years from 1932 to 1938 it would have been difficult to find in the United States any area of similar size where agricultural prospects looked more discouraging than in Baca County. At the end of that period only 650 farm families remained out of the 1,730 living in the county in 1930. Rainfall, normally 13 to 15 inches for the county, was subnormal for each of the 7 years 1932-38—the bad dust storms started early in 1934.

As one farmer said: "It was a bad year in 1934. The dust started blowing in the early spring and it hardly missed a day all summer long."

In 1935 the dust storms were worse and the "black rollers," for which Baca County is noted, came that spring. The next 2 years were no better. By 1938

the black rollers were becoming fewer but nevertheless the dust continued to blow. At that time it was estimated that there were 175,000 acres within the boundaries of the two districts on which not a sprig of vegetation of any type was growing. Weeds couldn't grow because the sifting dust and sand cut the small plants off as soon as they had emerged from the ground.

Today there is a different story to tell—soil conservation district supervisors report that only 20,000 acres will be subject to blowing in the spring of 1941. This is good news, and here is the story of what happened to change the prospects of farmers in this southeastern corner of Colorado:

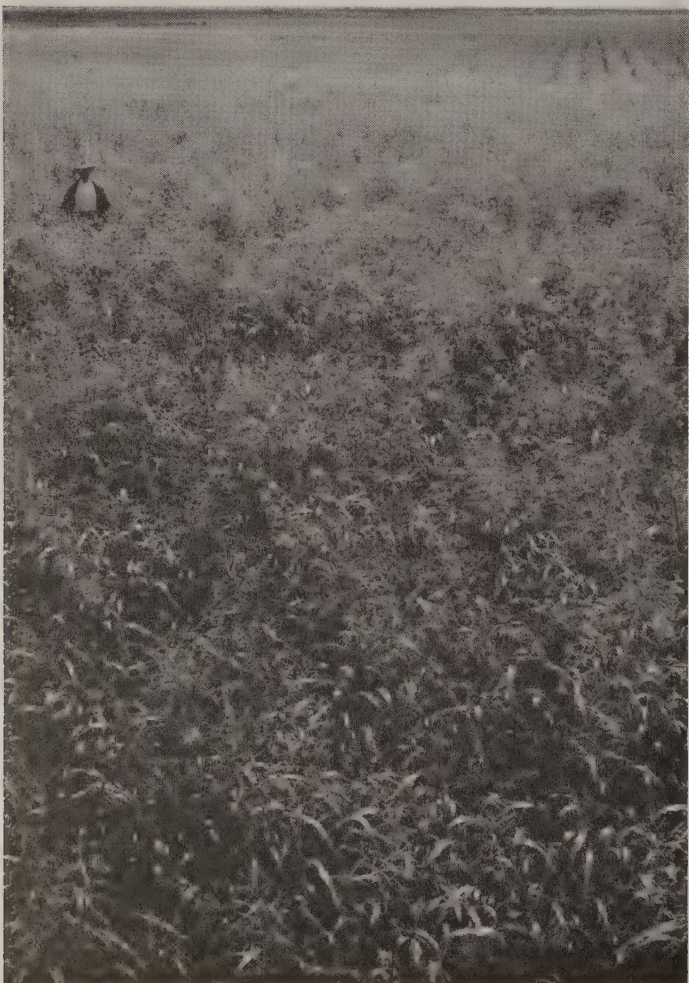
In 1935 the Soil Conservation Service established a demonstration project in the southern part of Baca County and during the same year a soil conservation C. C. C. camp was located at Springfield, the county seat. The Farm Security Administration included wind erosion control as a part of its program. The county agent did his best. The A. A. A. changed its crop control payments to soil conservation payments. All these—but still the dust continued to blow on an increasing acreage.

Early in 1938 the Department of Agriculture established a submarginal land purchase project in the western part of the county. It was at this stage that the farmers and landowners residing in the county took advantage of the soil conservation districts law of the State and organized their districts.

By the time these districts were organized, the Soil Conservation Service had been demonstrating erosion control practices to farmers of Baca County for 3 years. A demonstration of what to do to stop wind erosion is not of much value, however, to a section of bare land in Colorado, the owner of which lives in Connecticut or California and on which no tenant resides. The land itself won't put soil conservation practices into effect—not in Baca County. The problem of bringing under control the idle, abandoned land was one of the chief worries of the supervisors of the two districts. Lack of finances to expend on soil conservation practices on the part of most resident farmers, who had not had a crop in 7 years, contributed to the difficulty of the problem.

The supervisors of the two districts worked hard in drawing up work programs and plans for a permanent system of agriculture for their communities. The immediate and pressing problem confronting them, however, was not the establishment of a long-

¹ Chief, regional division of information, Southern Great Plains Region, Soil Conservation Service, Amarillo, Tex.



time program of soil and water conservation by farmer members of the districts; because it simply couldn't be done in Baca County while thousands of acres of wild land were blowing 5 or 6 months out of the year and depositing loads of unproductive silt on the cropland of those who were attempting to farm. The idle land—land abandoned by the 970 families that had left Baca County, had to be brought under control before those who remained could farm their land.

In April 1938, the Department of Agriculture, under terms of its submarginal land purchase program began to take options on some of the most severely eroded land of the county. In the fall of that same year the Western Baca County District leased 11,000 acres of land that was owned by absentee owners and had been lying idle for several years. They used emergency tillage methods during the winter and spring to stop blowing on this acreage.

The next spring, 1939, the Western Baca District leased 56,000 acres and planted cover crops of broom-corn, Sudan grass, cane, and other erosion- and drought-resistant sorghums on it. They financed these operations with loans from the Farm Security Administration, secured by the A. A. A. soil conservation payments that were due on the land. The leases that were given the supervisors by landowners were for the nominal sum of \$1 per year per farm and included the rights to all A. A. A. payments on the land. When the A. A. A. payments were made, the supervisors found that they had enough money to repay the loans from the Farm Security Administration and retain a small operating capital in the district treasury. The Soil Conservation Service furnished them some equipment and technical assistance in running contour lines. In the meantime, the Service planted cover crops on several thousand acres that the Government had bought.

The Southeastern Baca Soil Erosion District also began to lease land and plant cover crops on it in 1939. In the spring of 1940 the Western Baca District leased some 30,000 acres on which they planted sorghum crops while the southeastern district leased some 15,000 acres and treated it in a similar manner. Indi-

A typical field leased by supervisors of Western Baca County Soil Erosion District. Above, the field as leased in November 1938. The supervisors that fall instituted emergency tillage measures, and in the following spring planted the field to a cover crop of sorghums. Below, the same field in September 1940, after the second year's growth of crops. Approximately 60,000 acres of land have been stabilized by the district; another 15,000 acres have been treated by the Southeastern Baca District.

vidual farmers of the county also began to lease neighboring blow land and bring it under control.

In the spring of 1939, for the first time in 6 years, the amount of land subject to severe wind erosion decreased in Baca County. It decreased again in 1940. In fact, very little really "wild" blow land remained in the districts by midsummer of 1940.

The supervisors of the two Baca County districts realized, however, that the leasing of land and establishment of a cover of sorghums and weeds on it was not a permanent solution to the problem. This was merely a temporary, emergency measure.

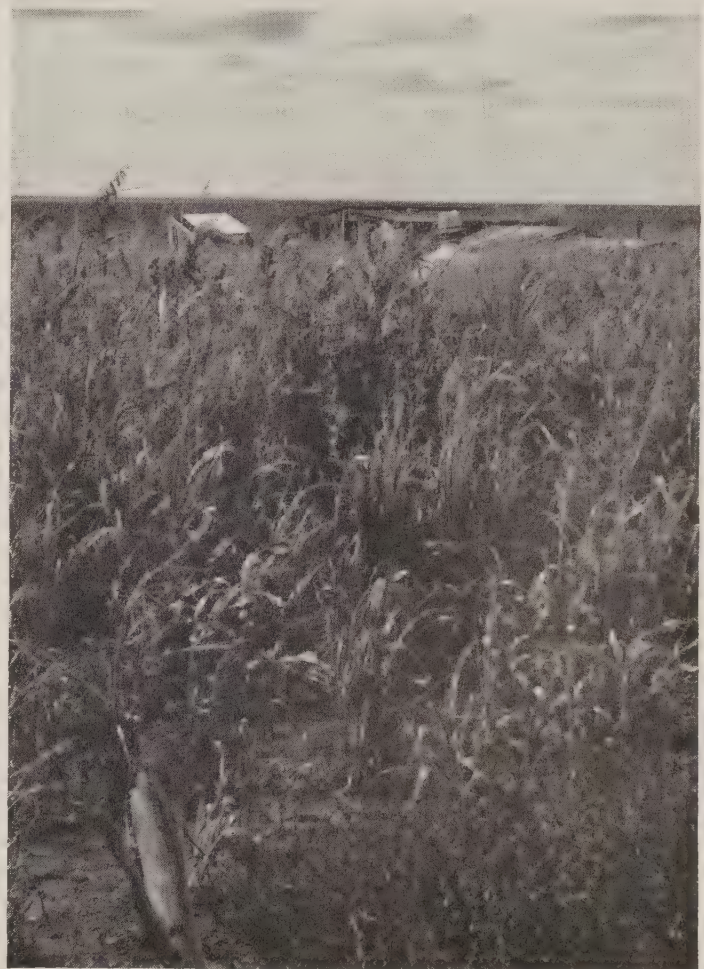
In order to accomplish their ultimate objective they felt that a permanent program of soil and water conservation must be established on all of the land in the districts. This meant conserving water by terraces, contour tillage, strip cropping, contour furrows, and all other means. It also meant better crop management; the getting away from cash-crop wheat farming and returning to a livestock economy with sorghum feed crops as the principal cultivated plants. As Sam Gordon, chairman of the board of supervisors of the Southeast Baca District, said, "Any man who attempts to make a living in this country by straight wheat farming will eventually go broke."

Realizing that they must protect their gains if ever they were to establish a permanent program, the supervisors of both districts found it desirable to put to a vote of the landowners and farmers, in their respective districts, the proposition of compulsory land-use regulations. The principal regulation, passed by these districts, was that sod land cannot be broken out without the supervisors' consent. The supervisors give their permission for the plowing up of grassland in Baca County only when it can be shown that the land is suitable for cultivation. Not much land of this type remains unbroken in the county, so in substance the regulation means that there will be very little sod breaking in the future. By applying these regulations the supervisors prevented the breaking out of 1,280 acres of sod land in 1940.

In drawing up the district programs it was found that most of the farms of Baca County were too small

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View on a tract of land in western Baca County that was purchased by the government under provisions of the submarginal land purchase program of the Soil Conservation Service. The farmstead in the upper picture is as it appeared when bought in May 1940. The lower picture is of the same scene in September 1940 after a cover crop of sorghums had been grown as anchorage against wind erosion. This land is to be retired to grass.



COLORED LAND-USE MAPS GUIDE FARMERS

BY WALTER W. JOHN ¹

"THE colors on those maps told me how to handle my land better than anything else I've seen," said Arnold Ellinghuysen, as he explained the farm plan he had worked out with the Rollingstone-Stockton-Gilmore Creek Soil Conservation District in Winona County, Minn. He was referring to the colored land-use capability maps which he had made with the help of the district.

"It is easy to see what each color means; the plow shows me where yellow land leaves off and red land begins, just as it is on the map. Now I know what they mean when they talk about land classes," he added.

Arnold and his 16-year-old son, Kenneth, are operating 273 acres owned by an insurance company on a share lease. The farm was purchased by his grandfather in 1865 and was owned by his family until a few years ago when the insurance company took it over.

The cropland stretches along a narrow ridge surrounded by steeply sloping wooded ravines. Strip cropping and contour farming suit the farm ideally, and the operator says he would not farm any other way now. About half the farm was in cropland, but that has been reduced to about 90 acres. Contour fences are being built to separate the pasture from woodland on one side and cropland on the other.

Kenneth, already an "A-1" conservationist, told what contour farming means to them. "Last summer our neighbors, who plowed the old way, could get in

their fields a day or two sooner than we could, but they didn't harvest a crop equal to ours. We got 55 bushels of corn to the acre last year; we raised more on 10 acres than we used to on 30 acres. I plowed 20 acres myself; it's easier than the other way."

The boy explained the pasture system they were following. "We now have three pastures under our conservation plan. We'll put the cows on one for 2 weeks and then change to another. We're cutting down on corn and hogs and are growing more hay. In that way we can spend more time taking care of our cows."

The Ellinghuysen dairy herd now consists of 26 cows, mostly Holsteins. The two farmers plan to enlarge the dairy barn and increase the herd to about 40 cows. Kenneth is taking a keen interest in improving the dairy herd, just as he is in improving the land. He said that he had not studied conservation in the nearby grade school, but he believes "they'll all need to learn about it some time."

Arnold Ellinghuysen is proud of the "kid" and of his younger son and three daughters. There are several Ellinghuysens in the Rollingstone-Stockton-Gilmore Creek district and most of them are cooperating with the district. Arnold said that the group-planning meetings held by the district convinced him of the need of protecting the land.

Arnold wants to buy the farm, but he and the owner have not been able thus far to agree on the price. "The trouble is," he remarked, "after I build up the soil the owner may decide it's worth more money."

¹ Associate information specialist, regional division of information, Upper Mississippi Region, Soil Conservation Service, Milwaukee, Wis.

NEW HOPE FOR AN OLD FARM

BY WALTER W. JOHN

WHEN 6 years ago Harold Neverdahl moved to his father's farm in Dunn County, Wis., he found that it wasn't the farm it used to be. Today, after his first year of "level" farming, he has hopes of saving it from erosion.

Neverdahl, now in his early thirties, told of having helped his father harvest some good crops from the 94-acre farm. "One year Dad got 1,300 bushels of grain, and even sold some hay, but we can't do that now. Something has gone out of this land. We have let the soil get away from us. I believe we just

didn't know what was happening until it was almost too late."

It looked like a losing struggle, but this farmer did not "take it sitting down." Across the creek he saw his neighbor, Emil Jensen, applying soil conservation practices with much success. Jensen was getting some assistance from the C. C. C. camp at Menomonie. When Dunn County farmers organized a soil conservation district, early in 1940, Harold Neverdahl decided to see what could be done to "put the old farm back in shape."

He called on district technicians to advise him about farming on the contour. A technician helped him lay out contour lines for strips on one field which he plowed out in June. These contour lines proved the value of conservation to him and with the plan he worked out, using the contours as a beginning, he now thinks he can stop most of the wash on his cultivated land within 2 years. Next year he will have all of it contoured and strip-cropped in a 4-year rotation of corn, oats, and alfalfa.

The farm drains in four directions and large gullies are cutting in from each side. One gully, more than 20 feet deep, was advancing about 10 feet a year toward his barn and was getting dangerously close. The farmer built a small diversion dam to head it in another direction. He stopped a smaller gully by planting trees in it. The biggest gullies still have him worried.

"If I can get help to stop these big ditches, I want to buy the farm," Neverdahl said. The land has been in the family almost a hundred years, and the home

tie is strong.

Young Neverdahl operates the farm on a crop-share lease with his father, Albert. Although economists probably would not class the 94-acre farm as an "economic unit," the operator thinks he can make it pay through his herd of 20 grade cows. Most of the farm is on rather steeply sloping land, some as much as 18 percent, and mainly "blue" land. Under the present plan, 35 acres are in rotation, 28 acres in pasture, and 23 acres in timber. He may increase the acreage of hay as a substitute for corn silage.

Neverdahl believes that Dunn County farmers can solve most of their erosion problems by farming on the level. "It keeps the soil from washing and makes it work better. There's more moisture for crops. Plowing is easier, too," he said.

In addition to being a cooperator with the soil conservation district, Harold Neverdahl also is a township A. A. A. committeeman. With his conservation program and assistance from the district and the A. A. A., he intends to "make a go of the farm."

NEW HAMPSHIRE NEEDS DISTRICT LAW

(Continued from p. 227)

return for carrying through recommended practices and plans. It means the coordinating of the efforts of public agencies concerned with these problems in order to accomplish the greatest good with the minimum of cost. Such assistance and subsidies to the landowners would compensate for increased labor and expenses involved in making corrections in the management of land that may or may not directly benefit the owners. As landowners reach a point in their thinking where they realize that land-use regulations must be applied for the good of all, although such regulations may appear to be to the immediate disadvantage of a few, they should have available the legal machinery to accomplish such an objective.

Because of the many land-use problems confronting the people of New Hampshire, it is believed that a soil conservation districts law would provide the machinery, so that the people can make the necessary corrections in the democratic way. Certainly, forest and other land-use regulations, applied to private lands, will be most effective when the people involved have full opportunity to discuss, frame, and decide upon the regulatory measures best adapted to an area. It is important, also, to remember that any regulations applied to farm lands and woodlands within a region, are related to, and affect the use of all the land. Consequently, forest management cannot be considered as a problem by itself, but needs to be coordinated with the land-use problems of an entire area. If in the

future the Federal Government should see fit to place upon all woodland owners the responsibility of keeping their woodlands productive, New Hampshire people through a soil and forest conservation districts law would have the needed legal machinery for assuming such a responsibility.

IT CAN BE DONE

(Continued from p. 235)

for practical livestock farming units. Hence, the districts are cooperating with the Farm Security Administration, the Soil Conservation Service, and the Extension Service in attempting to enlarge the average-sized farm of the county. This they call their "unit reorganization program."

J. H. Neal, chairman of the board of supervisors of the Western Baca County District, made this statement: "Since we have brought most of the abandoned land under control, farming of the other land should be much simpler. Some of the better land that has been idle and abandoned for several years was farmed again this year and several new farm families have recently moved into the county."

SOON TO BE PUBLISHED

Do soil conservation practices pay? In an early issue SOIL CONSERVATION will present convincing evidence drawn from the well-kept books of farmers with several years of conservation experience.—Editor.

A BANKER'S FOURFOLD OBLIGATION

BY W. JUDD WYATT¹



Clyde S. Branaman, Bedford, Ind., combines membership in a national farm loan association with soil conservation farming. Wheat harvested from the strips shown in the picture yielded from 5 to 10 bushels per acre higher than the field had ever produced previously.

EROSION is amortization in reverse. The close relationship that exists today between the purposes and activities of the Soil Conservation Service and those of the Farm Credit Administration has been built up, with careful attention to local and individual farm needs, in order to forward without delay a specific type of coordinated assistance to the people who work the land. While the Soil Conservation Service is showing farmers how to stop the tearing-down process of erosion, the Farm Credit Administration is showing them how they can build up their equities or their share in the ownership of their farms and farm homes. At the same time the Farm Credit Administration is advising members of national farm loan associations and production credit associations of the necessity for conservation farming.

The oldest of the four cooperative credit units of the Farm Credit Administration is the Federal land bank system, which since 1917 has provided farmers with long-term farm mortgage loans. Because of their low interest rate and long terms—sometimes as long as 34 years—Federal land bank loans meet a definite need in the advancement of American agriculture. However, another factor is largely responsible for fitting land bank loans to farm needs. That factor is amortization, a provision enabling a farmer to make small but regular payments on the principal of his loan.

In other words, a family with a Federal land bank loan uses amortized payments to build up a larger share in the ownership of the farm. Payment by payment, year by year, a reserve security is stored away and the equity in the farm business and farm home is increased. Each amortized payment on a



R. O. Cole, extension soil conservationist, Purdue University, has an interested audience of national farm loan association members as he speaks on the advantages of conservation farming.

Federal land bank loan builds toward a happier future.

The one characteristic of farm families that has stood out above all others, throughout the nearly a quarter of a century of Federal land bank mortgage loan operations, is their desire and determination to meet obligations and to own their farms and homes free of debt. The same period of time has also demonstrated most pointedly the necessity for farm planning and cultivation practices that will stop erosion losses while the amortized payments are increasing the farmer's equity in his farm. By working side by side the Soil Conservation Service and the Federal land banks are helping farmers to improve farm value through conservation farming while at the same time they pay for their farm.

The use of credit in the purchase of a farm or in making farm improvements is recognized as a good business practice. Industry uses credit and enjoys credit terms adapted to its needs. Prior to the establishment of the Federal land bank system, farmers were forced to use credit on terms suited to industry. The farmer who has a short-term farm mortgage loan that falls due in a lump sum is forced to follow a cropping system that lays his farm prey to the ravages of erosion and the evils of over-cropping. Even if, by pushing his farm to the limit, he is able to meet his short-term obligations,

¹ Information agent, Farm Credit Administration, Louisville, Ky.

he still faces the ordeal of several years in which he must rebuild his soil. The terms of a Federal land bank loan, on the other hand, are so designed that a farmer can plan his erosion control and soil conservation practices over a long period of years, and thus he is, throughout those years, in a much better position to follow through with his plan to put his land into the best possible condition for permanent and profitable use.

Thousands of farmers who have obtained Federal land bank loans through local cooperative national farm loan associations are cooperating in the program of the Soil Conservation Service. They have found that erosion control practices have increased yields and efficiency of production. In many instances tenants who had had the experience of operating farms within Soil Conservation Service demonstration project areas, immediately upon buying farms of their own, began using soil conservation methods with the aid of Federal land bank loans.

To acquaint national farm loan association members in the Ohio Valley with the fact that something can be done to control erosion losses, the Federal Land Bank of Louisville has joined with national farm loan associations, the Soil Conservation Service, and the Extension Service in sponsoring tours of soil conservation demonstration farms and areas. Many of these cooperative tours have been held in Indiana and Ohio, and they are now being extended to Kentucky and Tennessee. The Federal land bank has urged association officers and members to assist in Soil Conservation

Service district programs to the greatest possible extent.

In encouraging the adoption of soil conservation practices the Federal land bank recognizes a four-fold responsibility. One, and an extremely important one, may be summed up by saying that the land bank wants the farmer to be the owner of a profitable and permanent farm when the last payment on his loan is made. A second responsibility is to bondholders, in the protection of the soil which is the security back of the bonds—this since funds for Federal land bank loans are obtained from the sale of bonds to investors. Still another responsibility is to consumers, who are entitled to the assurance of continued supplies of food and fiber. The fourth and final responsibility is to future generations of the Nation; these people of the future have their rights even today, that we shall pass on to them the advantages of the cooperative credit system and the security of land that has been well cared for and in a high state of productivity.



John F. Hull, assistant general agent of the Farm Credit Administration, Louisville, here explains the advantages of soil conservation districts. Mr. Hull, until recent months county agent of Vanderburgh County, was instrumental in the organization of Indiana's first soil conservation district.

ONCE-IN-HUNDRED-YEARS RAIN

(Continued from p. 229)

strips developed on the site of former gullies will themselves repay them for all their labor. The rains we had in August demonstrated both to me and to my tenants the value of a complete water-disposal system, including both properly constructed terraces and meadow strips to take care of the run-off. The meadow strips surprised us all in the way they handled the run-off from the terraced fields. All of my tenants now are in wholehearted sympathy with the work." Mr. Brodie also expressed the opinion that meadow strips and terraces planned for his farm and established within the past year at a cost of less than \$1 per acre had increased the value of his farm to the extent that if sold at auction it would bring \$5 more per acre than before planning was begun.

Thus, in spite of all the damage of rains and floods, farmers in soil-conservation districts in North Carolina are not discouraged. They have a new insight into the need for and the value of a sound conservation program and they are going about the job of

protecting their land with more determination than ever. It may be that such rains come only once in a hundred years, but they are not taking chances.

In connection with district work in the tobacco-producing areas of Virginia and North Carolina, farmers and district technicians have developed a rather unique scheme for crop rotations on tobacco land. On this type of land farmers use the following rotations: 1-year tobacco followed by oats and 2 years of grass, or, tobacco followed by 2 years of grass or grain in strips on the contour. Some of the land in the field where tobacco is grown may not be suitable for tobacco; on such land, corn or cotton is planted in the same strip as tobacco, followed by grain, grass or a legume, thus permitting clean cultivation around the slope in the cultivated strip of clean-tilled crops and harvesting of the close-growing crops in the same strip. The development of this scheme provides the farmer with a safe and sound way of using all the land within a given field, with ease as to cultural operations.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neill Faris

CONSERVATION OF AMERICAN RESOURCES. By Charles N. Elliott. Edited by Paul W. Chapman, Dean of the College of Agriculture, University of Georgia, Atlanta, Ga. November 1940.

This new 700-page text, or reader, for public schools, is fairly complete without being too involved and is so interesting that it is hard to put it aside once you have picked it up. It is so profusely illustrated that the person accustomed to scrutinizing and analyzing many books is moved to make a count—there are 315 illustrations.

Certain features are handled unusually well. Interest—the author incites interest, then captures it, by devices entirely legitimate. Children love animals and animal stories—wildlife is the first American resource treated as a “unit.” Forests are next; and then the land, the soils, by which wildlife live and in which great trees are rooted.

A second unusual feature of the book is the honor code method used by the author to appeal to the pride of American youth in an abundant land and at the same time enlist their support in a broad program to restore and preserve all resources—birds and animals, fish, forests, soils and waters, farm and range lands, minerals, landscapes and homes and communities. Honor codes not only train in “playing fair” with the land and the waters, the forests and wildlife; they introduce activities and organizations in which young people can participate to hasten restoration and “make fast” good habits and policies of conservation.

The “50 conservation messages, which come from America’s conservation leaders” constitute another unique and valuable method used in this new textbook. Appropriately placed throughout the volume, these messages, many of which were written especially for the children who will study the text, introduce to the conservationists of tomorrow those great leaders of today who in their highly specialized fields are refining and perfecting conservation means and methods and at the same time working wholeheartedly to correlate knowledge and hasten the trend toward a lasting conservation policy for America. This “message” device, bolstered by photographs of those from whom the messages come, is most effective in that it fits so well the purpose of a conservation course in public schools. The 50 names constitute a most impressive list: It begins with Jay N. Darling; you find along the way H. H. Bennett, W. C. Lowdermilk, Russell Lord, under the “unit” Land; Herbert Hoover, Zane Grey, Stuart Chase, F. A. Silcox, Paul B. Sears, Ovid Butler—but the list is too long for this space. It ends with John W. Studebaker, U. S. Commissioner of Education. The book is dedicated to these 50 leaders.

Paul W. Chapman, editor, and dean of the College of Agriculture of the University of Georgia, has written the Foreword. He points out certain features of the book in the hope “that teachers and pupils will make use of these sources of information”—the glossary of “conservation words,” the extensive lists of “readings in conservation” arranged to conform with the organization of the text. Other very useful lists for teachers and students are included also. It is more or less a certainty that these sources of information are going to be used.

WORKING PLANS FOR PERMANENT FARMS. By Glenn K. Rule, Soil Conservation Service. United States Department of Agriculture Miscellaneous Publication No. 411. Washington, D. C. October 1940.

Probably the best method of getting the most out of the working type of bulletin is to outline as you read. This bulletin on working plans for permanent farms resolves itself into seven steps of planning. First, find out the existing facts about the farm—the soils, steepness of slopes, extent of erosion, present land use, and the climatic factors such as rainfall, temperatures and wind direction and velocity. In this first step the farmer’s help is essential, since he knows more about the land he works than any other person could possibly know. Second, make a use-capability map. As Mr. Rule defines it a use-capability map is “an interpretation of the pertinent physical facts about a given piece of land as these facts relate to its practical use.” Three land-use capability maps are shown, in colors, and finished farm plans matching them, so that the user of “Working Plans for Permanent Farms” can have no doubt as to their meaning and value. As a matter of fact, in this bulletin is to be found the best account of this phase of planning that the reviewer has seen anywhere.

The third step: Consider, from all angles, the economics of the farm—the farmer’s resources and needs. Obviously, no one other than the farmer can provide the information required here. He knows his past years of labor and what he has realized from that labor; he knows his essential requirements in the matter of income and feed and food supplies. These requirements are given careful thought and attention, along with all other known facts, in the fourth step—the making of a preliminary working plan for the farm, something to use as a basis for discussion of land use as related to production and conservation of the soils.

The fifth step brings into the picture the element of cooperation among several or many farmers whose lands adjoin to make a block that can be handled economically for production, for conservation of the soil, and for permanence of the farm as an institution. Group meetings are held, and the farmers talk it out, with their use-capability maps and their preliminary plans and recommendations before them. Then, and this is the sixth step, each farmer makes his own working plan, with a technician’s help if such help is wanted, on the land of his own farm.

The seventh step involves the completed individual farm plans based on all known facts concerning the area of land and the people who use the land as a source of livelihood. The completed farm plan consists of five parts: the land-use capability map; a land-use map; a plan of operations; a job sheet sequence; an organization summary.

The latter half of the bulletin is given over to three sample farms, one in the Piedmont of the Southeast, one in the Texas Panhandle, and the third in southeastern Minnesota near the Mississippi River. The discussion of these farms is especially valuable in that it explains the details of land-use change required on so many farms for conservation of the land itself.

For REFERENCE

Compiled by **ETTA G. ROGERS**, Publications Unit



SOIL CONSERVATION DISTRICTS

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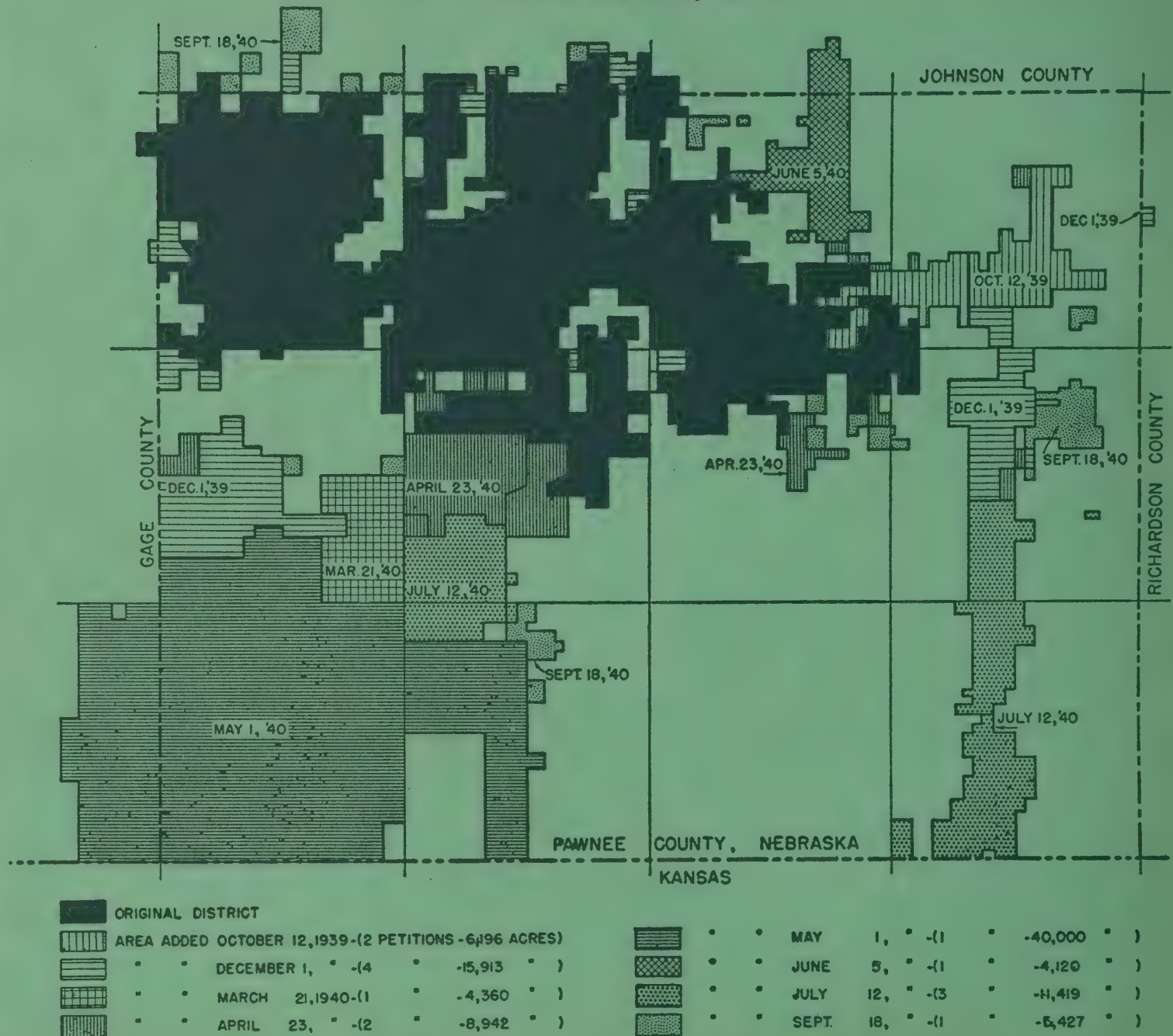
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NOTE.—Because of limited space, this list does not include all of the material developed by the States for use in their District programs. To date, 16 States have developed outlines of the basic provisions of their laws; 21 States have prepared outlines of their laws which in some cases supplement their "Basic Provisions," and in other instances are used in place of the provisions; and 18 States have developed informational and educational materials dealing with their district programs, for use by farmers and others.

OF THE FARMERS, BY THE FARMERS, AND FOR THE FARMERS

HOW THE TURKEY CREEK SOIL CONSERVATION DISTRICT GREW

(See article by A. E. McClymonds)



TOTAL 15 SEPARATE PETITIONS TOTALING 96,377 ACRES ADDED IN LESS THAN ONE YEAR

THIS map demonstrates more clearly than words how soil conservation is proving its own worth to farmers and how farmers are rallying to soil conservation. Here, as elsewhere throughout the country, a relatively small number of conservation pioneers provided the motivating force to start the original district. From the surrounding countryside came other farmers; they saw, and were convinced. In the district they found the means and opportunity to put their will to work in holding fast their soil and means of livelihood. The district grew, for it was more than a mere administrative mechanism; it was the rallying point for expression of cooperative community action. As the story of the Turkey Creek Soil Conservation District shows, it is a living thing, growing from the initiative and conviction of its farm people, and is rooted deep in the very soil and society that the district is set up to preserve.—H. H. Bennett.

APRIL 1941

BARRINGTON KING

WRITES ABOUT

**MACK GOWDER'S
FARMING
METHODS**



SOIL CONSERVATION

**OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON**

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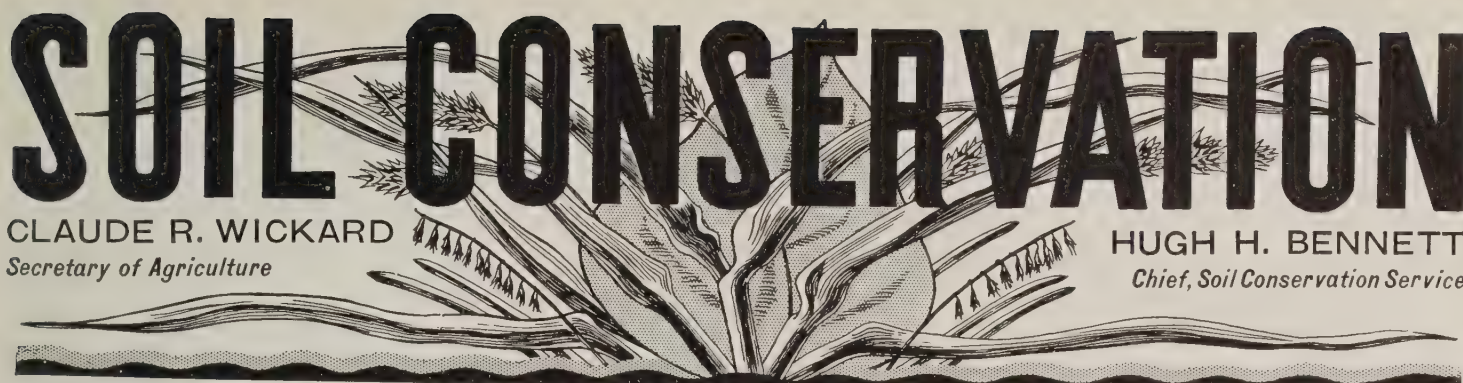
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WELLINGTON BRINK
EDITOR

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CLAUDE R. WICKARD
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

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APRIL • 1941

AN ICE STORM IN TEXAS

BY H. K. ROUSE¹

DESTRUCTIVE ice and sleet storms in New England, in Pennsylvania, in Illinois, yes; but in the Panhandle country!

The ice storm of November 23 and 24, centering around Amarillo, demonstrated that "it can happen here"—in Texas. This was a storm that will take its place in song and story along with the blizzard of '88. Already tales of freakish happenings during the storm have taken on stature reminiscent of chuck wagon yarns. The 1,500 linemen rushed in from Houston, St. Louis, Denver, and a thousand miles around, performed feats worthy of a Paul Bunyan in restoring light, power, and communication.

Aside from heroic proportions, the bare facts of the storm are of absorbing interest. It was severe over an area roughly 100 miles square in the Panhandle of Texas, including the towns of Dumas, Channing, and Vega, in addition to the city of Amarillo with a population of 55,000. Less severely the storm extended as far as Tucumcari, N. Mex., and Dalhart, Tex. Notable features were the almost complete destruction by ice of all wire lines with resultant stoppage of light and power services, and disruption of all forms of wire communication; also, because of failure of power lines, water supplies were cut off or drastically limited. With telephone and fire-alarm lines down and water supplies extremely limited, it seems providential that no conflagration occurred. These conditions, beginning early in the morning of November 23, persisted until the afternoon of November 25.

At Vega, Tex., a county seat 35 miles west of Amarillo, the Soil Conservation Service conducts

studies of precipitation and run-off on three watersheds. Recording instruments consist of seven recording rain gages, three water-stage recorders, and one hygrothermograph. All instruments functioned properly during the storm and excellent records were obtained. The following discussion is based on these records together with observations made by Harry Leonhardt, district conservationist of Oldham County wind erosion district, and Joe L. Harris, engineering aide, who services the instruments and collects the records from the run-off studies.

Prior to this storm there was a great deficiency of precipitation. The first 10 months of the year (1940) yielded only 8.20 inches, as compared with the normal for Vega, 18.20 inches. This shows a deficiency of 55 percent. The four preceding months—July, August, September, and October—had yielded but 2.78 inches of precipitation, a deficiency for this period of 72 percent, as compared with the normal 9.97 inches. The ground had become so dry and hard that many farmers were unable to plant winter wheat.

During November there was no precipitation until Tuesday, November 19. Rain, changing to snow, began that morning and continued intermittently for 24 hours with an average yield of 0.74 inch on the three watersheds. This precipitation soaked into the ground immediately, the snow melting almost as rapidly as it fell.

The storm of Saturday, November 23, began at 2 o'clock in the morning and continued, except for short intervals, until 11:45 Sunday night, a total of 46 hours. The total rainfall on the three watersheds averaged 3.5 inches, the catch of the several gages ranging from 3.21 to 3.74 inches. In character, the rain was gentle with small drops. The maximum intensity of rainfall

¹ Line project leader, hydrologic division, Southern Great Plains Region, Soil Conservation Service, Colorado Springs, Colo.

was 0.35 inch per hour, and the maximum fall in any one hour was 0.23 inch, between midnight and 1 a. m. on November 24.

During the period of the storm the air temperature remained at 31° F., not varying more than 1° up or down, from 8 p. m. on Friday, November 22, until 2 p. m., Monday, November 25, when a rise in temperature began. This constant temperature was accompanied by almost complete cessation of air movement.

The combination of factors—the slow, cold rain, prechilled surfaces, a uniform subfreezing temperature and absence of wind—produced coatings of ice wherever the rain touched. Beautiful formations transformed weed patches into fairy gardens; slender wires grew to ropes as large as a man's arm; prosaic barbed-wire fences sagged to become festoons of crystal. Beauty soon was joined by destruction. Within 4 hours after the beginning of the rain, the high line serving Vega from the central station in Amarillo went out, leaving the town without light or power and with an almost empty water-supply tank. During the day the telegraph and telephone lines failed, and the town was without communication.

As the storm continued and the weight of the ice increased, wire lines continued to fail until, within the town, it was difficult to find two adjacent spans of wire still up. The not too recently built high-tension electric line suffered most severely. In many places 8 to 10 or more poles in succession were broken off; where poles stood, cross arms snapped. In a 10-mile stretch not over a dozen poles remained undamaged. The least severely damaged line was a telephone and telegraph transcontinental trunk line paralleling U. S. Highway No. 66 from Amarillo through Vega to Albuquerque, N. Mex. The local telephone lines and the railroad telegraph lines, which were less substantial, suffered so severely that they had to be rebuilt.

Normally the Texas Panhandle is a treeless plain; getting shade trees established is difficult, and once established they require careful maintenance. In the past 30 years, however, civic and individual effort had succeeded in establishing many beautiful trees along streets and surrounding homes. During the storm the ice formation on trees was beautiful, but soon the picture became tragic as the weight of the ice broke branch after branch. Practically every tree of any size suffered severe damage so that ruthless pruning or complete removal was necessary. The pruned trees present a pitiful sight; only the main trunk and 8 or 10 mutilated branches remain of what very recently was a spreading shade tree.

Fences, too, were severely damaged. Much wire

will have to be restretched and many fences rebuilt. Livestock suffered some discomfort during the storm. All forage was completely covered with ice, and local stockmen were compelled to provide supplementary feed. Though the weather was hard on stock, no appreciable loss was experienced since the temperature did not drop below 30° F. and forage became available again on the fourth day.

All recording instruments functioned well and complete legible records were obtained.

This storm's characteristics were decidedly not of run-off producing quality. The intensity of rainfall was low, the ground was not frozen and was very dry following 4 months of drought. Where vegetation was plentiful canopy interception was great, holding back probably $\frac{1}{3}$ to $\frac{1}{2}$ of the total precipitation for from 12 to 36 hours after rainfall ceased. The records of the three watersheds are given in the following:

Watershed W-I (Bower), consisting of 130 acres, is divided into approximately equal areas of cultivated land and pasture. The cultivated land includes slopes of from $\frac{1}{2}$ to 1 percent and had been planted to winter wheat. The pasture land has fair to good cover and an average slope of 2 $\frac{1}{2}$ percent. The total run-off from this watershed amounted to only 0.002 inch; this means that practically all of the rainfall (3.45 inches) went into the soil. The peak rate of run-off was only 0.6 cubic foot per second.

Watershed W-II (Landergin) consists of 96 acres of range land with good vegetative cover and an average slope of 1 $\frac{1}{2}$ percent. No run-off occurred on this watershed. All of the 3.21 inches of rain was retained.

Watershed W-III (Landergin) consists of 21 acres of rough, broken range land having a stony soil, sparse vegetative cover, and steep slopes averaging 10 and 30 percent. The slightly heavier precipitation (3.74 inches) produced much higher run-off from this watershed, but even here the total run-off amounted to only 0.5 inch (13.3 percent of the rainfall) and the peak rate of run-off was only 1.17 cubic feet per second.

The small percentage of run-off and consequent retention of most of the moisture in the soil has resulted in excellent soil-moisture conditions. Test holes dug 10 days after the storm showed good moisture to depths varying from 19 to 30 inches.

While the publicity given this storm generally classed it as a disaster, this was principally because 100,000 people in an area as large as the State of New Jersey were suddenly cut off from regular communication with the rest of the world. Property damage undoubtedly was heavy. The population suffered some

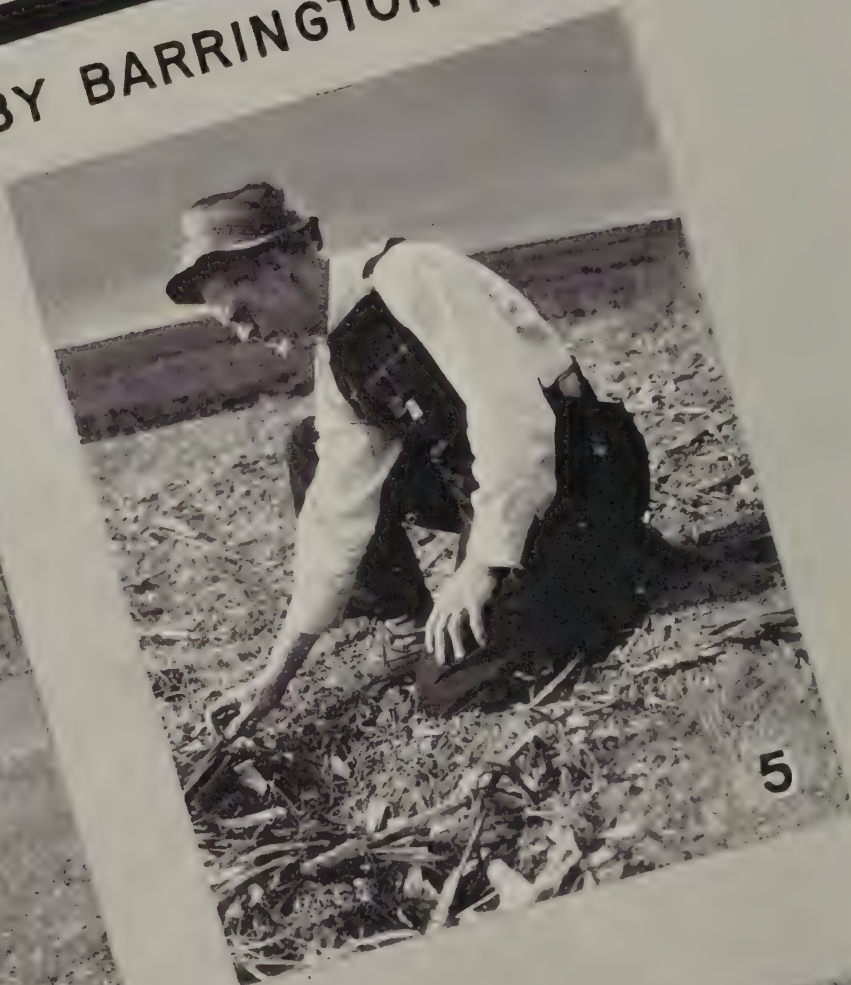
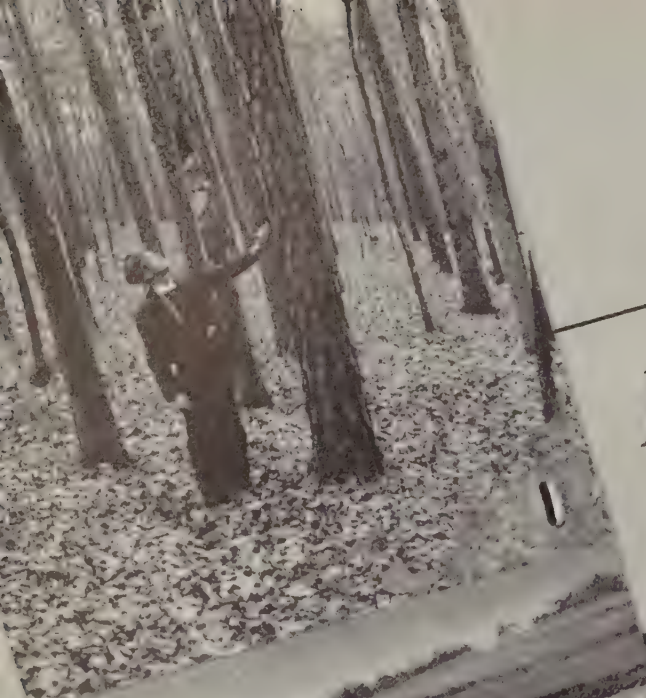
(Continued on p. 248)



*Top.—Typical ice-loaded fence and rural telephone line,
Vega, Tex.
Center.—Ice-damaged trees in the Oldham County court-
house park.
Bottom.—Local distribution lines of the electric-power
company.*

HARD WORK, BUT NO HARD TIMES

BY BARRINGTON KING



MACK GOWDER went about the job of farming the hard way when he bought a farm of his own on the steep slopes of Hall County, Ga., 20 years ago. His neighbors told him that if he had accumulated enough money to buy some land he ought to go to South Georgia where a fellow could raise twice as much with half the work that it took in those steep North Georgia hills.

But Gowder had his own ideas about farming and he wanted to put them into practice on his own land in the same neighborhood where he had spent his boyhood days on his father's farm. He figured he could raise as much as he and his two boys could gather and besides, he told them, he was "foolish" about the good spring water of the North Georgia hill country and didn't have any desire to "drink out of frog ponds"—meaning the shallow wells of flat country.

During the 20 years since Gowder bought 100 acres of woodland, cleared the land for his fields, and built his home on the top of a hill above a flowing spring with the timber he cut from his woods, there has been plenty of hard work on the Gowder farm, but no hard times. Today the farm is an outstanding example of what a Southern Piedmont farmer can accomplish, not under the most favorable, but under the most difficult circumstances any farmer is likely to encounter.

If there is any secret to the system that has made the Gowder farm outstanding—in a section where the best soil from hundreds of other farms long ago was washed into the Chattahoochee River—it is that Gowder has made conservation not only a principle of farming but a habit of living as well. He has followed consistently a few simple farming practices that have

kept the soil of his cropland, woodland, and pasture in its original healthy condition; it never has been necessary for him to mine a living from eroded soil.

The practices that Gowder has been using are simple enough, but they are scientific in principle. His method of utilizing crop residues to protect soil from erosion is, in fact, a farm practice that stands far out toward the front in conservation farming. In other words, *he is now using on his Georgia hill farm a soil-protective system of farming that most of the Nation must come to, in one form or another, if we are to have complete conservation, and a permanent agriculture, in the United States.*

It is generally conceded that holding the soil and growing row crops on slopes of 15 to 25 percent, as Gowder has done, is an extremely difficult undertaking. A lot of farmers have tried it, usually with disastrous results; Gowder not only has made a good living from the land on his farm but he can say, and does, that the soil of his fields is better today than when the land was first cleared. When a Southern Piedmont farmer can say that, he can command attention wherever the subject of agriculture is discussed.

Mack Gowder doesn't carry out on his farm a definite conservation plan in the generally accepted sense of the term. The sequence of crops in his rotations is determined to a large extent by seasonal conditions, rather than by long-time planning, and he has followed with dogged Irish determination a few general principles that he knows to be sound. He had seen the soil wash away from local farms where he had worked and had refused to accept such loss as a natural result of making a living from the land. He resolved that if ever he had a farm of his own, he would maintain the land in its original fertile condition. Now he sees nothing very unusual about what he has accomplished; it is merely what he had set out to do 20 years ago.

"You've got to feed the land just like you feed a mule," Gowder says, and he has found that the best way to feed the land—or the mule—is to grow the feed. Stated briefly, his farming program includes (1) utilizing all crop residue on the land; (2) deep plowing with a sharp-pointed, modified bull-tongue plow that breaks the subsoil without turning the land, mixes part of the crop residue with 2 or 3 inches of the topsoil and leaves most of the crop residue on the surface; (3) contour tillage; and (4) simple rotations that include a large proportion of small grains, cowpeas, and O-too-tan beans, and a small proportion of cotton and corn.

Probably the most effective soil protection on the

Note—The author is Regional information specialist, Southeastern Region, Soil Conservation Service, Spartanburg, S. C.

1. Mack Gowder examining timber in his 75 acres of woodland. The excellent litter underfoot is a result of protection from burning.

2. Terraces and trashy cultivation on a field in Gowder's farm in Hall County. Residue in abundance was left from the previous corn crop.

3. Otis Gowder breaks the land with a special type of bull-tongue plow which loosens the soil to a considerable depth without turning it, mixing the plant residue with the top 2 or 3 inches of soil. The mules are allowed to "just creep along" to prevent the strain of deep plowing.

4. Deep plowing is a key practice on the Gowder farm.

5. Mack Gowder examines a heavy mulch of cornstalks and weeds, with which he achieves protection for his land.

Gowder farm is that provided by the heavy mulch of crop residue which can be seen on the land at any season of the year. In the fall, much of the land is planted to oats and wheat to provide some additional protection for the land and contribute feed for the livestock, wheat for the family flour bin, and a surplus for sale. Cowpeas, harvested throughout the fall whenever members of the family can spare the time to pick them, is another field crop which furnishes food, feed, and a supplemental source of cash income.

Gowder's idea of the importance of proper plowing gives an insight into the thoroughness with which he goes about the business of farming. He lets his mules "just creep along" when he is plowing his land, because deep plowing is hard on workstock even in the mellow soil of the Gowder farm; and besides, "a fellow can do better plowing when his mules don't go too fast." Most of the plowing is done in the fall when there is no rush about getting crops planted and when the ground, even if it is a little wet, has all the winter months to weather—"condition"—beneath the protective mulch of crop residue.

The only thing Gowder ever burned on his farm was the brush that was left when he cleared the land and used the timber to build his home 20 years ago. Since that time not a leaf, not a stalk, not a weed has been burned. All crop residue—cottonstalks, cornstalks, pea vines, bean stubble—is left on the land, the only exception being residue of O-too-tan beans that are cut for hay. When bean hay is harvested, small grain is planted to protect the land as soon as the hay is raked.

The only time he ever uses a turning plow is for plowing out the channels of his terraces. For all other plowing he uses a special type of bull-tongue plow (a modified "Georgia scooter") with a sharp point which he forges himself. After cutting up the crop residue with a disk harrow, he breaks the ground with this special plow which, by *plowing through the stubble* rather than turning it under, serves the double purpose of subsoiling and land breaking and mixes part of the crop residue with the top few inches of soil.

A typical rotation on the Gowder farm consists of corn, with cowpeas sowed in the corn when the crop is laid by. After the peas are picked, the vines are left on the land to be disked and followed by oats in the fall. When the oats are harvested the following summer, the land is plowed, peas are sown, and the litter again is left on the ground after the peas are picked.

Another rotation consists of cotton followed on part of the land by oats and another part by wheat,

after the stalks are cut and the ground is disked. Peas are sown the following summer after the grain is harvested. After the peas are gathered the land is broken, and the litter is left on the ground. In the spring the land is disked and planted to cotton or corn.

Terraces appear to have been an afterthought on the farm "to take care of floods," as Gowder expresses it, and were built 5 or 6 years after the land was cleared, when most of the stumps had been removed from the new ground. The terraces—of the channel type, with a steep drop on the lower side which is necessary because of the steepness of the land—are spaced much farther apart than is customary and in some instances have a vertical interval of as much as 16 feet.

Because of the highly absorptive condition of the soil as maintained by the abundance of crop residue and the deep plowing, there is no appreciable run-off at the terrace outlets, "except with a rain of 4 to 6 inches in a night," Gowder told us. In spite of the fact that he grows his row crops on slopes of 15 to 20 percent, no evidence of soil washing is found in the terrace intervals, terrace channels, or at the terrace ends where Gowder has constructed simple rock outlets for individual terraces which empty into woods or road ditches.

When Gowder undertook the terracing of his land he did so only after the same kind of thorough study that he gives every farming operation. He ran the lines with a 12-foot triangle and a carpenter's level and limited the grade to a fall of 2 to 4 inches in 100 feet. To keep from removing too much topsoil from any part of the field, he explains, he used a drag pan for the construction job, starting well above the terrace line to get the soil for the ridge. Much this same method of terrace construction has been developed by the Soil Conservation Service and is now being used successfully in soil conservation districts in many parts of the Southeast and neighboring States.

Keeping his rows level to prevent the land from washing away was one of Gowder's first conservation practices. He has practiced contour tillage ever since he plowed the first furrow, long before his terraces were built. He says he has found that he can produce from one-fourth to one-third larger yields by spacing his rows far apart and planting his crops thick in the drill. He plants his grain in 18-inch rows and his cotton and corn in rows 4 to 5 feet apart.

With an allotment of 9 acres, he planted only 4 acres to cotton in 1940 and produced 4 good bales. Depending on conditions, he makes from 1 to 2 bales of cotton to the acre, 40 to 75 bushels of corn, 25 to 30

bushels of wheat, and 40 to 50 bushels of oats. Some idea of the effectiveness of his farming program can be gained from the fact that the average oat production for Hall County is 15 bushels per acre.

With respect to acre yields, Gowder's output is probably at least three times the average output of most similar farms in the locality. He is saving his soil and working a profit while doing so.

On a measured acre of land he has made 90 bushels of corn in a favorable season, and 5 years ago he sowed 5 bushels and 1 gallon of wheat on 6 acres and threshed 206 bushels of wheat. He uses 150 to 200 pounds of fertilizer per acre on most of his crops, as compared with 250 to 300 pounds used on the average farm in the section.

The cropland, however, has not been forced to carry the entire burden of providing the cash income for the farm. Of the 130 acres he now owns, Gowder keeps 75 acres of the steepest land in woods—woods that had been badly damaged by annual burning before he bought the farm. By protecting his woodland from fire and making improvement cuttings each year, he is developing an excellent stand of timber. He is harvesting a cord of wood per acre from the improvement cuttings, thus providing the largest cash return from any single crop on the farm.

By removing only the dead, diseased, misshapen, or stunted trees in his annual cuttings, he leaves the better timber to grow eventually into a crop of sawlogs. With the aid of a small motor-driven saw, he converts most of his cordwood into stovewood lengths which he delivers to regular customers in Gainesville and elsewhere for \$6 a cord. The remainder, above his own fuel needs, he sells as cordwood in 4-foot lengths for \$4 a cord. Gowder and his son Otis cut and haul most of the wood themselves.

An important factor in the successful operation of this farm—one not so apparent as is the mulch of crop residue that can be seen on the land—is Gowder's faculty for extending the principle of conservation far beyond its application to the soil. Even a casual observation will reveal that conservation has been carried into every phase of the operation of the farm as an economic unit.

The speedometer on a large 1936-model sedan under a shed back of the house registers only 2,600 miles, and except for the lines of the body it looks as if it might just have come off the assembly line. On the other hand, the truck that hauls products of the farm to market shows every indication of having made innumerable journeys over the 10-mile stretch of county roads to Gainesville and other nearby communities.

"Every time I take the car out of the shed it costs me money," Gowder explains with a twinkle of Irish humor in his eye, "but when I take the truck out I always bring back more than I had when I left."

When winter rains have turned the county roads into a sea of mud, the area between the house and barn is hard and dry; it is covered with a deep layer of gravel which Gowder hauled from an old abandoned railroad bed several miles away.

The devastating tornado that almost destroyed the town of Gainesville about 5 years ago missed the farm, but it ripped from buildings and scattered for miles across the countryside pieces of galvanized roofing which Gowder accepted in the literal sense as "wind-falls." Most of the pieces were badly twisted by the fury of the storm, yet they serve very well as sides for various sheds and as covering for the stovewood that is always piled in the yard for future delivery to customers.

The bottoms of battered steel oil drums, salvaged in town, have been carefully cut off with a cold chisel to form heavy steel tubs about 14 inches deep to solve effectively and once for all the problem of indestructible hog troughs on the farm. The funnels Gowder uses for transferring gasoline from 50-gallon drums to his car and truck are made from large gourds merely by cutting the large part of the gourd in half and opening the end of the handle for a spout. Tin funnels could be bought at the 10-cent store for a dime, but Gowder grows his funnels along the fence for nothing.

Gowder always has something to sell and little to buy. Hickory, cut from his woodland, is shaped with a drawing knife into ax handles—he sells them for 25 cents each. Wheat straw for bedtick filling is sold to families in the neighborhood for 25 cents when they bring their ticks to the farm and fill them, and for 50 cents when he picks up the ticks in his truck and delivers them full of straw.

Gowder is "always experimenting on something." Over a period of 17 years, by careful selection he has developed his own variety of corn that produces ears of the desired size, shape, and number of rows with hard, flinty grains, and other characteristics. He sells 80 to 90 bushels of corn a year; about half of it is seed corn which brings \$2 a bushel.

Oats are cut and fed unthreshed, and of the 75 to 150 bushels of wheat produced, about 30 bushels are used for flour and the remainder is sold. Approximately 75 bushels of peas are harvested each year, of which 40 to 50 bushels are sold.

Some vegetables are sold from the garden as well as a little surplus fruit from 20 apple trees, 20 peach

trees, 5 cherry trees, and scuppernong and grape vines, although all feed and food crops are considered first from the standpoint of home needs. Coffee, sugar, and salt are about the only staple items on the purchase list of the Gowder farm.

Livestock includes 2 mules, 4 cows, 1 boar, 2 sows and 8 pigs, and about 40 chickens. Some milk, butter, and poultry products are sold to a few regular customers on Gowder's trips to town, and the sale of pigs nets around \$50 to \$100 a year. Most of the livestock products, however, are consumed on the farm.

In addition to the 100 acres he bought 20 years ago, Gowder recently purchased an additional 30 acres. Most of it is being developed for pasture, but he expects it will be a long time before he gets it in the same condition as his "old" land. Some of the new land he has planted to kudzu, and he has also a small amount of *Lespedeza sericea* which he uses for hay, along with his O-too-tan beans. About 28 acres of his old land is in cultivation, with 2 acres in the house site and garden.

Often Gowder is urged to sell the timber on his 75 acres of woodland; and for some time a salesman has been after him about putting in a ram to pump water to the house. As to the timber, he knows that with the careful management he has given his woodland, the trees are just now reaching the stage where they are really making volume growth. He is still uncertain about the ram to pump the water to the house; maybe that mountain water might not taste as good as it does when he carries it in a bucket up the steep hill from the spring.

No electric line is available in the vicinity of the Gowder farm. The spring at the foot of the hill takes the place of an electric refrigerator. Meals prepared on a wood range with fuel produced on the farm somehow seem to be cooked to just the right degree without the aid of heat-control gadgets, and an open log fire that would be the envy of many a city housewife fills the house with warmth and cheer on chill winter evenings. There is a modern touch, however, to the kerosene lamps with Welsbach mantles that give an amazingly fine light and still retain the simple charm of the rooms.

Gowder's wife and seven children have helped keep the farm on a paying basis through fat years as well as lean. The farm has experienced 2 severe droughts during the past 20 years, but there has always been plenty of food on the table and a savings account in the bank. The two boys, Otis, 28, and Frederick, 23, were graduated from North Georgia Agricultural College at Dalonega. Otis and his wife live on adjoining land and help with the work on the farm, but Frederick

decided he "didn't want to follow a hard tail (a mule) all his life" and moved away to town.

Two girls finished high school at Clermont and are now married and living on nearby farms. Three younger girls, ranging in ages from 17 to 9, are still on the farm and attend the consolidated school at Brookton.

Gowder himself attended a one-room school in his home community. He started to school at an early age. His mother died when he was a baby and there was no one at home to look after him but two sisters—when the youngest sister started to school he went with her. The one-room school at Dewberry community was heated with a fireplace and young Mack helped the other boys bring in wood for the fire. One lesson learned in these early school days has stuck with him ever since—always keep plenty of dry wood on hand against a rainy day.

All members of the family are musical, and singing is one of the chief diversions on the farm. Ever since the first two children were old enough to join in the harmonizing there has been a vocal quartette, and someone to play the piano accompaniment. Members of the family take part in "singing conventions" in the nearby counties as well as in their home community.

A visitor in the Gowder household may enjoy an unusual experience when in the evenings after the supper dishes have been cleared away the family gathers around the piano in the parlor to sing with mellow harmony some long-forgotten song. The uncertainty of events across the sea seems very far away, but the security that all the world is seeking is very near indeed.

In Chief Bennett's opinion, Mack Gowder has made a contribution of national importance to the science of soil conservation, particularly in his method of conserving crop stubbles and plowing deep without turning the soil.

AN ICE STORM IN TEXAS

(Continued from p. 242)

inconvenience, perhaps even a little hardship, but there was no real suffering. The farmer will be put to some extra work and expense in repairing fences and rural phone lines, but he suffered no loss of crop or livestock. The one great and irreparable loss is to the shade trees.

On the other side of the ledger, the moisture put into the ground is of incalculable value. It made it possible for many farmers to plant their principal crop, winter wheat, and the soil-moisture conditions resulting from the peculiar storm are the best in many years. The farmer is almost certain to harvest a good crop, even though the first half of 1941 may be deficient in rainfall.

FARMERS WORKING TOGETHER, TOMBIGBEE-WARRIOR DISTRICT

BY JOHN C. SLONE ¹

TO assume that sound farming can be achieved in a soil-conservation district without group action is somewhat visionary and at variance with the history of education. Group action as a means of promoting education of the masses is not a new technique. Some of the early records of teaching deal with groups. The early characters of the Bible were given instruction and teachings, then told to call their tribes together into groups and disseminate the information to them. The practice of instructing by groups has proved its value down through the ages and is now evident in our churches, schools, colleges, political rallies, and community meetings.

It has been said that the difference between presenting an idea convincingly to an audience of 1,000 persons and to an audience of one person is that the latter is more difficult than the former. An audience of 1,000 persons usually will listen to the speaker without interrupting him, but the one person audience is likely to interrupt over and over again. Unless the person trying to get a statement across to the audience of one is well prepared, he is likely to find himself confused.

Yet, a person may go before an audience of one person with but a vague idea, if any, of what he is going to say. He hopes to plunge in and get through somehow. No person with any consideration for his cause, his audience, and himself would go before a large audience without a carefully prepared talk, with his points arranged in logical sequence, his arguments carefully thought out, and the entire address well fixed in his mind. This applies equally to professional agricultural workers and is one of many sound reasons for giving consideration to group action in a district program.

Another reason for using the group-action method in a district program is the saving in time and money and the increased efficiency made possible by dealing with groups as compared with the individual-contact method.

The general belief among agriculturists is that one of the greatest handicaps to the establishment of an improved agriculture is the lack of interested, intelligent

local leadership. It is necessary to develop the traits of leadership in several persons of each community so that a progressive program may be built up from discussions of these leaders, with the interest of the whole community in mind.

I believe that the progress that has been made in the program of the Tombigbee-Warrior Soil Conservation District in northwest Alabama can be attributed to the application of group action. I am not foolhardy enough to intimate that we know all the answers, or that we even know many of the answers; but, we have found that the leaders in the local communities are interested not only in their own soil-conservation problems but in those of their neighbors as well, and that they are willing to encourage concerted action in solving them.

Since the beginning of actual operations in the Tombigbee-Warrior Soil Conservation District in Alabama, which was about October 1939, the district has helped farmers within its boundaries to accomplish much soil-conservation work on their farms.

Six hundred and sixty-three farm-conservation plans, involving many more farm families and covering 86,176 acres, have been developed in the district. Establishment of many of the practices called for in these plans is going forward at a creditable rate. For instance, 2,700 acres of improved rotations and about 1,500 acres of perennial vegetation have been established on eroding lands, and meadow outlets have been prepared for several hundred acres in advance of terrace building—and terrace construction is above obligations in the agreements.

Most of this work is now being undertaken through the community group approach. This is evidenced by the fact that 38 community group meetings have been held and attended by 626 farmers; 236 other educational meetings have been held by the district, with the result that requests for group farm planning work have come in from many communities. Tours and demonstrations pertaining to soil-conservation work have been participated in by more than 1,100 farmers. Soil conservation, community by community, has become the theme among the farmers as well as the agencies assisting the district.

Let us take the New-Home Community of Marion County, a part of the Tombigbee-Warrior district, as

¹ District conservationist, Soil Conservation Service, Tombigbee-Warrior Soil Conservation District, Winfield, Ala. The article is adapted from an address delivered by Mr. Slone before the Association of Southern Agricultural Workers, Atlanta, Ga., February 6, 1941.

an example. This community is located 12 miles from Hamilton, the county seat, and 6 miles from a railroad and a paved highway. The soils are naturally poor, the farms small, hilly, and badly eroded as a result of producing row crops. The owners operate the farms with family labor in most instances and the income is low. About the only thing outstanding about the community is its leadership.

When the district began operation late in 1939 a general educational meeting was held in this section of the county, and J. G. Davis who attended the meeting made application to the supervisors for assistance in farm planning. When, early in 1940, Mr. Davis had not yet received assistance, he went to see County Agent E. G. Small. In the meantime, the district supervisors had decided to change their approach to farm planning from the individual-contact method to the group-action method. Mr. Small explained the change in procedure to Mr. Davis, and pointed out that the available technical personnel for farm planning was limited, that farmers' problems were similar, that problems of erosion did not begin or stop at property boundaries, and that any material or radical change in agriculture in his community must be sponsored by the farmers of the community. Mr. Davis agreed that the reasons were sound, but insisted that he needed assistance and was interested in considering the program in more detail. Mr. Small suggested that he discuss the new procedure of group action with his neighbors to determine whether there was sufficient interest to justify the organization of a group in his community for promoting soil-conservation work. He also assured him of assistance from the district supervisors should there be sufficient interest to justify action.

Mr. Davis returned to his community, discussed the new procedure with his neighbors and learned that they were willing to join in asking for assistance from the district in an organized approach to the solution of their problems. He called a meeting of all farmers in the community at the community center and invited the county agent, the district work-unit technician, the Farm Security Administration supervisor, and the vocational teacher to meet with them. Mr. Davis presided at the meeting and introduced all visitors to the group. He then outlined the reason for calling the meeting and gave a general statement of the need for assistance from the district. He asked County Agent Small to give a general discussion of the district conservation program as it affected his community. He then asked the work-unit technician who represented the district to give a detailed explanation of the district

program. Visual aids were used in this discussion. The Farm Security Administration supervisor and the vocational teacher were requested to join in the discussion and they outlined the contributions which they could make to a community program.

When the discussions were ended Mr. Davis stated that he was willing to proceed with a complete conservation program on his farm in cooperation with the district, and he asked his neighbors to join him in a community-wide program. Fourteen of his neighbors made application to the district supervisors for assistance at this meeting. The farm of Mr. Davis was selected by the farmers to be used for field study in farm planning since it was centrally located and fairly representative of the group. A date for the field study was set and the meeting was adjourned.

The work-unit technician asked a soils technician to complete a conservation survey for the farm of Mr. Davis and, when this had been done, the remainder of the farms in the group were surveyed. He used this conservation survey and the land-use-capability map to assist Mr. Davis in preparing a complete conservation plan for his farm prior to the date set for the group field meeting. Conservation survey and land-use-capability maps were made for all farms in the group before the next meeting.

The fifteen farmers who made application for assistance met on the Davis farm at the agreed time and Mr. Davis led them over his farm, discussing the proposed changes and treatments. He was assisted in this by the work-unit technician. Questions were asked and explanations were made as the study progressed. An effort was made to get each farmer to visualize his individual farm as the various practices were discussed.

When the field study in farm planning was completed, each farmer was given a conservation-survey map and a land-use-capability map for his farm. The work-unit technician explained the symbols and how they should be used in farm planning. Each farmer was asked to take his maps home, go over his farm, and prepare a farm plan using the information gained at the meetings. The work-unit technician arranged to assist each farmer individually in completing his farm plan as rapidly as possible.

In no instance did the individual farmer make a complete farm plan as we think of the term; but in all cases the farmer associated the proper treatment with the problem and it was only necessary for the planning technician to make certain refinements, prepare the land-use map, assist in planning rotations, and prepare the agreement form. The usual long discussions as to

the proper treatments needed were eliminated as the farmer had incorporated into the farm plan such practices as he thought would help him with his problem. It became his farm program, prepared by him with the assistance of a technician in whom he had confidence—a program planned to fit his particular needs. Naturally, in these circumstances the farmer would feel proud of his accomplishment and would try to bring his program to a satisfactory completion.

After the farms were planned the next step was the establishment of practices, as without the conservation practices a conservation program does not exist. The farmers of this group have many practices in common, and because of this Mr. Davis invited a trained agriculturist to meet with his group to teach them how the practices should be established. The place of meeting was selected, the materials and equipment were procured, and the group assembled. Full reasons for doing the job were given by the agriculturist, the technique was demonstrated, and then the farmers were encouraged to try their hand at it. They learned the method by doing the job.

It did not make much difference whether the practice studied was terrace construction, terrace maintenance, kudzu planting, preparation of seedbeds, timber-stand improvement, or pasture development. The procedure for organizing the meetings was essentially the same. It was important, however, to stress the reasons for doing the job as demonstrated, and the necessity, in many cases, for doing it at a particular time or season. This was true not only for the purpose of establishing the practice properly but for the purpose of developing the traits of leadership.

It will be noted that the leader, Mr. Davis, had a prominent part in the whole procedure. I think that this is a point to be given emphasis, because capable and interested leadership is the keynote of success in group action.

Twenty-four community groups have been organized within the Tombigbee-Warrior Soil Conservation District, with approximately 275 district agreements for carrying out soil-conservation practices. Some of the groups have been much more effective than others, but all have shown advantages over the individual contact method.

I believe that it is very desirable to hold a field meeting between the farmers and the technicians if there is an established Soil Conservation Service project or a C. C. C. camp area within reach. The group should be shown the established practices so that they will have a better understanding of what is proposed. No established project was available for

this group, however, and the field meeting was omitted.

With the development of proper local leadership a far greater progress can be visualized than has yet been attained. Why cannot several individuals who have the ability of leadership become interested in a conservation program for their community, just as they are now interested in the school and church? It seems just as plausible that farm community leaders should remind their neighbors of the time to maintain terraces, mow pastures, plant winter legumes, plant grain crops, or fertilize pastures as to remind them that a "singing" will be held on Sunday afternoon at the community center. This form of leadership might have a more tangible effect on the social well-being of a community than would the same time spent in the more traditional forms of leadership.

It seems to me that the solution of group action by farmers hinges to a large extent around the ability of the professional agriculturist to gain the confidence of the farmers, direct them in an understanding and solution of the problems at hand and imbue them with a determination, desire, and eagerness actually to take the position of leaders. Many professional agriculturists do have the ability to gain the confidence of groups. Those who do not have it certainly could become more proficient by studying their subject matter and personal approach and becoming more enthusiastic about their cause. Very few can listen enthusiastically to a speaker who has but a sketchy knowledge of his subject and who lacks enthusiasm.

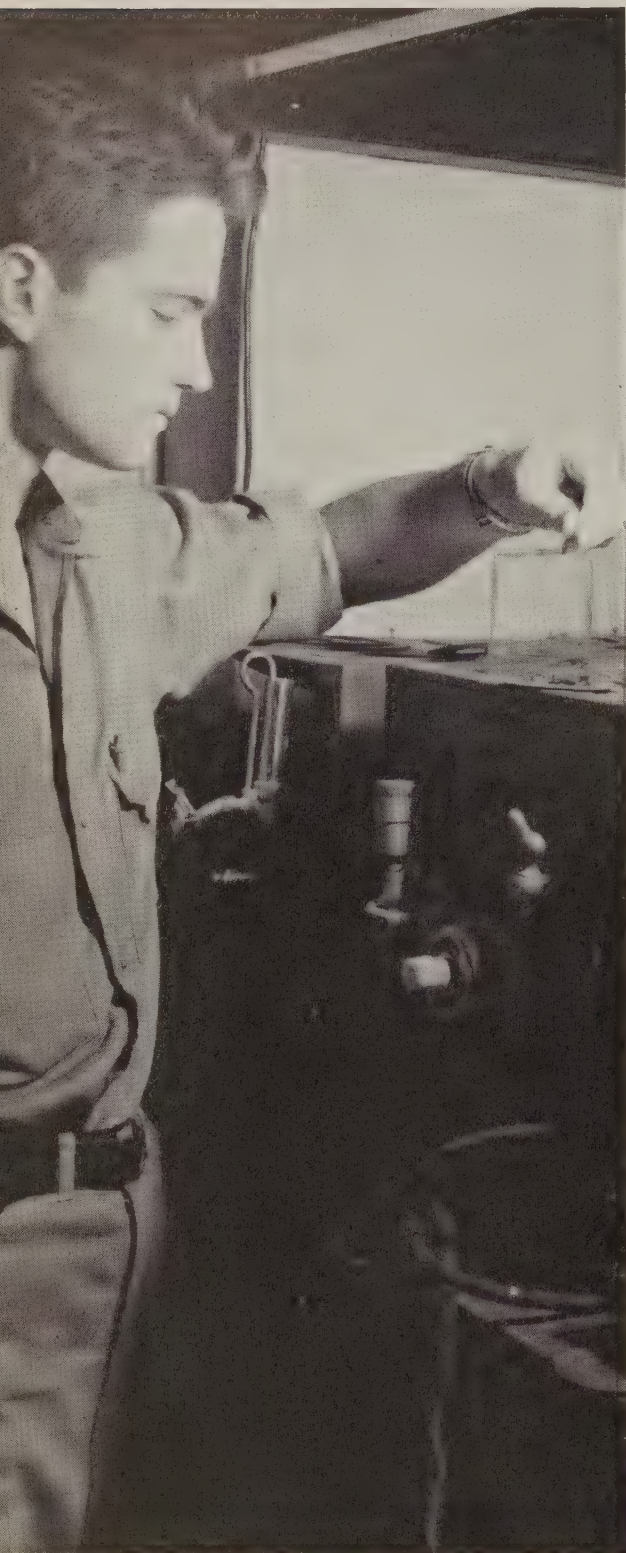
It seems essential that southern agriculture make drastic changes within a relatively short period to meet the conditions caused by national and international affairs. A well-organized community that is functioning as a group under local leadership, with the advice of qualified agriculturists, can make the needed changes much more efficiently than the same number of farmers each acting independently. On the other hand, it is undesirable for an agriculturist to assume that all farming practices in any community are wrong and to attempt to revolutionize a system within a year. A worth-while change in agriculture takes a longer time and can be carried out more satisfactorily when all parties are contributing to it. Farmers, by working as a group, can revolutionize their cropping system and farming program rather rapidly if they have interested local leadership with a vision that incorporates the whole community.

The teacher of vocational agriculture has an enviable position in the community. Usually he has become

(Continued on p. 264)

ELECTRIC POWER AIDS SOIL CONSERVATION

BY HARRY SLATTERY ¹



Gordon Inskeep stirring liquid in a beaker on an electric hot plate, Soil Conservation Research Station, Coshocton, Ohio.

THE electric distribution lines spreading over rural America at an unprecedented rate provide new tools for the soil conservationist. He can use the availability of electricity to encourage diversification in one-crop areas. He can use it to bring about better pasture management. He can use it to foster improved irrigation pumping practices in the arid regions and to encourage supplemental irrigation, where desirable, in the humid regions.

Indirectly, rural electrification can assist the soil conservation program by providing power for local industries. Such industries can help to check human erosion in three tangible ways. They can make part-time farming practicable in many marginal areas where it is difficult, perhaps impossible, to earn a decent living by farming alone. They can provide jobs for farm boys and girls who cannot be absorbed on the farm. They can provide a home market for farm products that must be processed for ultimate sale to distant consumers. All this is apart from what electricity can do to make the farm and the rural community more attractive to the boys and girls who grow up there.

The foregoing statements are based, not on conjecture, but on experience gained during the past 6 years in widely differing communities in 45 States. The Rural Electrification Administration, now part of the United States Department of Agriculture, was set up on May 11, 1935. Since that time, the ratio of American farms having central station service has increased from just over 1 in 10 to nearly 3 in 10. In round numbers, the increase has been from 744,000 to 2,100,000. Roughly half of the newly electrified farms get current from R. E. A.-financed lines, most of which are operated by cooperatives and other nonprofit organizations, including a few public bodies. The rest are served by private utilities and by various public agencies that have not used R. E. A. financing.

Coincident with the increase in farms served during the past 5 years has come vast widening of service areas. This has been due chiefly to R. E. A. From the first, the agency has insisted that its borrowers adopt the principle of area coverage. Newly formed cooperatives plan their power systems in advance so as to reach as many farms as possible, instead of running a few lines along the main roads and leaving farmers in the thinner territory to fend for themselves. Through a combination of simplified construction and large-scale operation, R. E. A. brought down the cost of rural lines from the old range of between \$1,200 and \$2,000 to less than \$1,000 a mile at the outset; today the average over-all cost of R. E. A.-financed lines is below \$800 a mile.

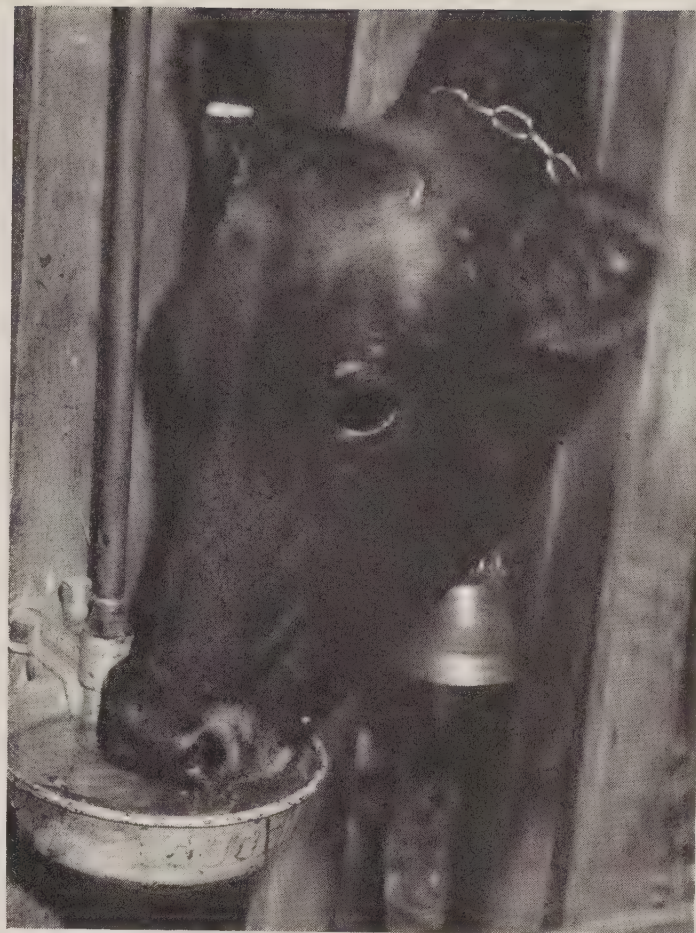
During R. E. A.'s first year, it financed a few lines. Before it could begin large-scale operations, it had to develop new techniques. It also had to foster a relatively new type of electric power organization, the farmers' cooperative. The private utilities, which many had expected would be large borrowers, if not the principal borrowers, have failed, with a few notable exceptions, to take advantage of the extremely favorable terms on which R. E. A. funds are offered.

Nonetheless, the utilities promptly began to increase

¹ Administrator, Rural Electrification Administration, Washington, D. C.

their rural mileage. Whereas rural electrification in 1934 was dead on its feet and utility spokesmen were explaining that electricity was going to farms as fast as was economically feasible and that it would be futile to speed it up, during the next 5 years they found rural service so far profitable that they increased the number of their farm customers by more than half a million. In many areas they have made their terms of service less onerous and have lowered their rates. Today the utilities have largely abandoned the practice of requiring a farmer wishing service first to advance all or a large part of the cost of the extension required to serve him.

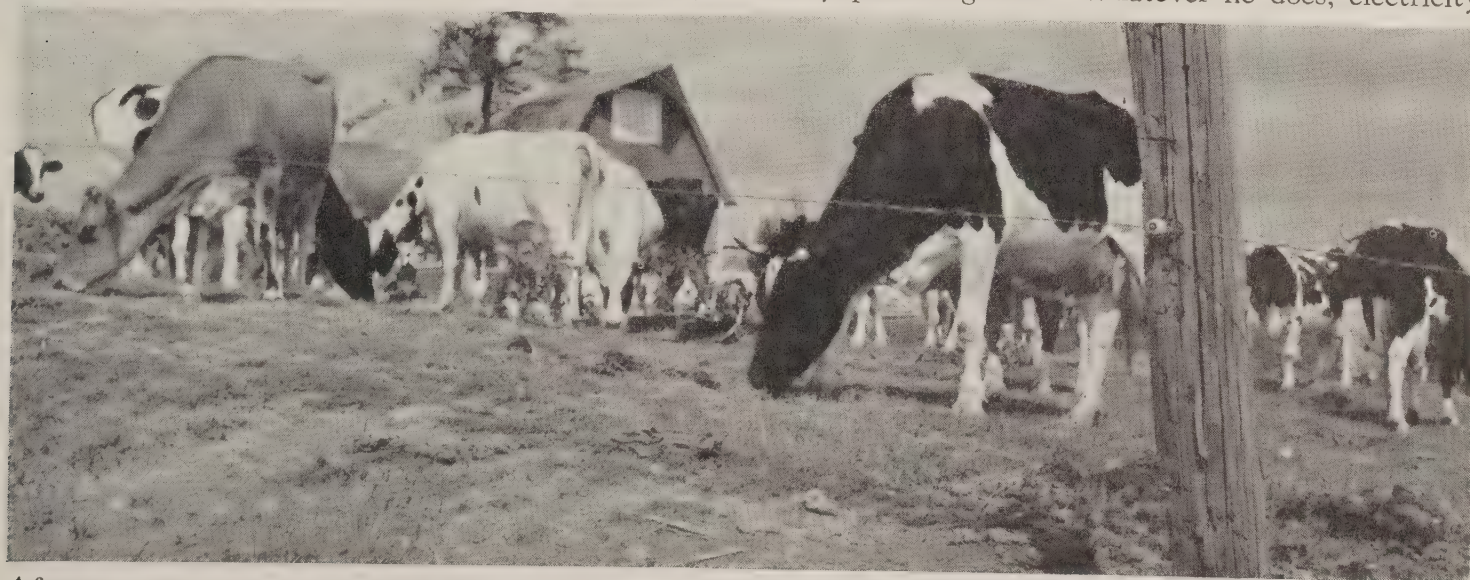
Hand in hand with the widespread extension of electric service to rural areas has come an increasing emphasis upon productive use of electricity on the farm and in the farm home. The old notion that electricity is a luxury which the farmer cannot afford is giving place to realization that it is a necessity he cannot afford to do without. R. E. A., the research agencies of the Department of Agriculture, the Tennessee Valley Authority, the Extension Service, State agricultural colleges and experiment stations, and manufacturers of electrical supplies and of farm machinery have cooperated in developing new equipment adapted to farm needs and in finding new uses for existing equipment. In a recent magazine article, Harry T. Garver of the Bureau of Agricultural Chemistry and Engineering estimated that there are now more than 250 uses for electricity on the farm and in the farm home. A single agricultural college is conducting 200 separate experiments that involve the use of electricity in farm operations. The files of R. E. A. are full of reports that tell how farm people all over the country have used electricity to increase their income, either by saving money, or in many



Stanchion cups furnish water for the cows.

instances by actually making money. Meanwhile everyone interested in rural electrification concedes that only a beginning has been made in the profitable use of electricity in agriculture.

Experience thus far indicates that a farmer accustomed to devoting all his energies to a single crop takes the first step toward diversification when he begins to produce part of his own food. He may start a flock of chickens. He may get a pig or a cow. He may plant a garden. Whatever he does, electricity



After one or two encounters with the electric fence, livestock soon learns to stay at home on the R. E. A. electrified farm near Herndon, Va. The electric fence, although effective, is harmless.

can help him. In the long run, it can help him directly by brooding his chicks economically and efficiently, by stimulating egg production during the winter months, by keeping his eggs and milk cool and fresh, by pumping water so that he can sprinkle his garden during dry spells. Before it can give such direct help, of course, the farmer must buy or build the necessary equipment.

Fortunately, the soil conservationist does not need to wait for the farmer to get electrical equipment, or even to begin taking service, before he can use a new rural electric power system as an opening wedge for diversification. The very fact that such a system has been organized and is about to be built gives him a chance to point out to prospective members the advantage of raising part of their own food or of developing supplemental sources of income.

Typical of what can be done during the early stages of a rural electric power system is the work of one Georgia county agent 2 or 3 years ago. His was a county in which cotton and tobacco-growing were the major farm activities. He had been preaching diversification for years with little success. As soon as R. E. A. made an allotment to a newly organized cooperative in his county, he began calling on the members. He talked over with them the coming of electricity. In the course of the conversation, he invariably brought up the question of how to pay the electric bill.

The county agent would remark that it seemed hardly wise to take on a new expense without at the same time finding a new source of income or saving. Generally the farmer would agree and ask for suggestions. That request was what the county agent had been angling for. Having received it, he suggested some source of home-grown food—a flock of chickens, an extra pig or two, a cow, or a garden plot. These suggestions bore fruit to the common advantage of the farm families and their cooperative.

After the new lines are in service, conservationists and R. E. A. alike have a stake in productive use of electricity. Primarily, R. E. A.'s interest springs from the fact that generally the sole security of its loans is the electric power system of a cooperative, and the sole source of principal and interest payments is the revenue that the cooperative receives from the sale of electric energy. Inasmuch as the loan normally runs for a quarter of a century, R. E. A. has a direct interest in the permanency of the agriculture of regions where it has or is likely to have investments. Inasmuch as such regions are found in all but 3 of the 48 States, the interest of R. E. A. in a permanent and prosperous

agriculture in all parts of the country is highly practical.

It is essential for the successful operation of a rural electric system that its members use electricity liberally. It is equally essential that they use it wisely, as otherwise many of them are likely to find that liberal use is a luxury they can ill afford.

Fortunately many of the more than 250 known uses of electricity on the farm and in the farm home are productive. Fortunately, too, those that are most likely to benefit the single-crop farmer require little initial investment. For instance, poultry-house lighting, which increases egg production during the months of short daylight and high prices, requires only a single bulb for every 100 hens. Any farmer handy with tools can build an efficient electric chick brooder at small expense; he can obtain plans at his R. E. A. system office. The farmer producing eggs or dairy products on a small scale can keep them fresh between deliveries, thus often receiving a better price, by storing them in his domestic refrigerator.

In a great many instances, savings effected through the use of electricity are substantial. Dairymen are finding electrical milk cooling to be not only more efficient than ice cooling but also less expensive. This is as true in northern regions, where natural ice can be cut from lakes and ponds and stored on the farm, as it is in the South and far West, where the farmer without artificial refrigeration must buy manufactured ice. Similarly, farmers who keep careful records have established the fact that electrical chick brooders are less expensive to operate than coal- or oil-burning brooders, as well as being safer and in other respects more satisfactory. Similar savings can be effected, in many cases, by the use of small electrically operated feed grinders; since such grinders can easily be set up for automatic or semiautomatic operation, the saving includes time, operating expense, and original investment. These examples of savings through the application of electrical energy to farm operations are only suggestive.

While the primary purpose of the R. E. A. program is to take central-station service to farms hitherto without it, R. E. A. systems also serve a wide variety of nonfarm consumers—churches, schools, country stores, filling stations, and various local industrial plants, as well as rural village homes. In many areas small plants powered by R. E. A. systems are providing part- or full-time employment to members of farm families. In addition, many of these plants process local raw materials, thus affording a market to farmers

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FIELD UNIT PLANNING

BY HARRY H. GARDNER¹

FIELD unit planning has developed out of several years of experience in soil-conservation work. In the early days Service technicians did all the farm planning, using various soil conservation practices in the effort to determine the best methods of conserving soil and moisture and to reduce erosion. Farmers knew little about the work and were willing to have the planning done for them.

With the advent of soil-conservation districts, farmers started to work out their own conservation problems with perhaps some assistance from Service technicians. This involves change in planning procedure: Farm plans must be simple, and the farmers must help develop them; crop rotations must really rotate, and the farmers themselves must be able to make necessary changes in the rotation without affecting the size or shape of strips or fields. Experience has shown that a farmer will follow a plan which he understands, one that is workable and flexible enough to stand changes in the farm enterprise or economic conditions.

These four distinct steps should be followed in field unit planning: (1) Delineating various land uses—the separation of cropland, permanent hay land, pasture land, woodland; (2) dividing the cropland into practical field units easily accessible for farm operations and for grazing; (3) developing a suitable crop rotation; and (4) planning the necessary supporting conservation practices.

The plans for three farms are presented here to explain the field unit method of planning. Figure 1 is a map of a 240-acre farm as it was operated by the farmer. The high percentage of clean-tilled crops should be noted, and also the arrangement of fields without regard to topography. Only the more nearly level land was used for cropping, while the rough land was fenced out for pasture. The farmer, to a certain extent, had learned something of proper land use by experience; but he had not learned how to maintain cropland in continuous cultivation without excessive soil losses.

Figure 2 shows a map of the farm with all four steps in field unit planning completed, i. e., areas have been delineated according to land use, the cropland has been divided into five field units, the rotation has been developed, and the supporting conservation practices

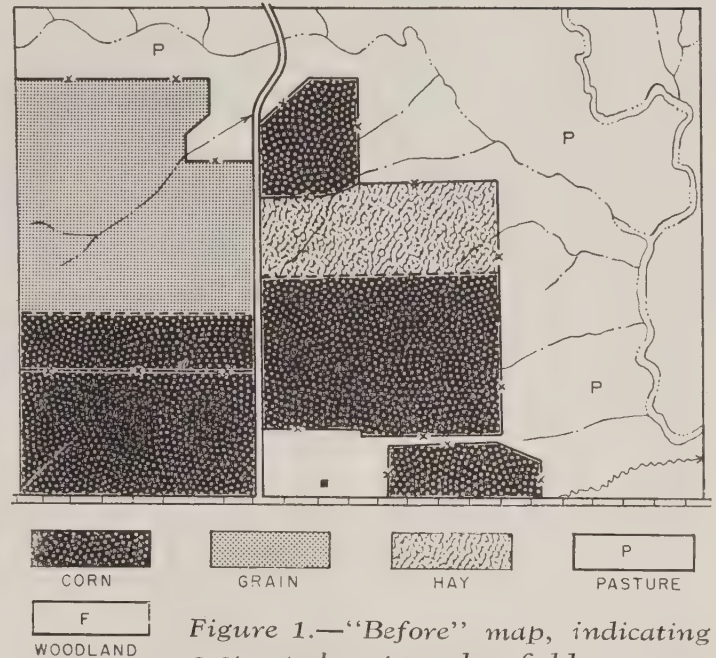


Figure 1.—“Before” map, indicating crops and rectangular field arrangement.

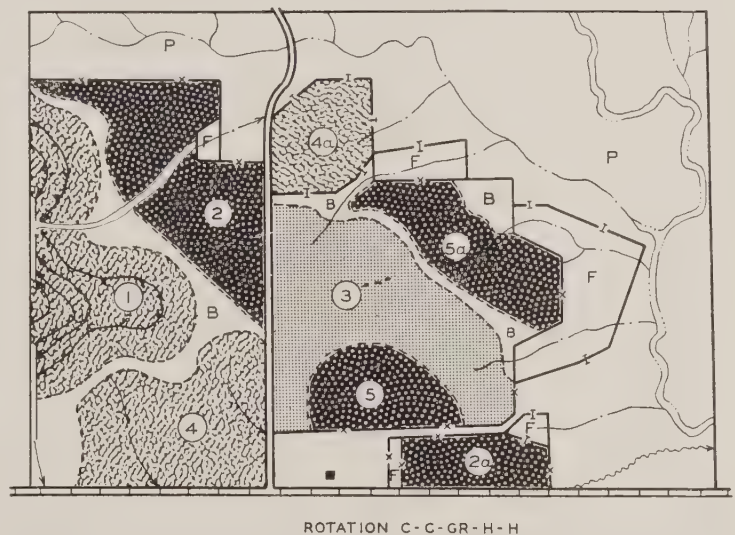


Figure 2.—Map of same farm, showing the four essential steps in field unit planning: (a) proper land use delineated; (b) cropland divided into five units; (c) rotation of C-C-Gr-H-H planned; (d) supporting conservation practices established, terraces and contour buffer strips (B).

have been established. In order to maintain proper balance of crop acreage it was necessary to lay out some of the units in two fields. For example, fields 2 and 2a are worked as a unit, likewise 4 and 4a, and 5 and 5a. The rotation of corn-corn-grain-hay-hay is common rotation that has been recommended for this area for a long time, but the arrangement of this rotation in the five units to be farmed on the contour is an adaptation to conserve the soil resources of the farm. It is sometimes necessary to use more support-

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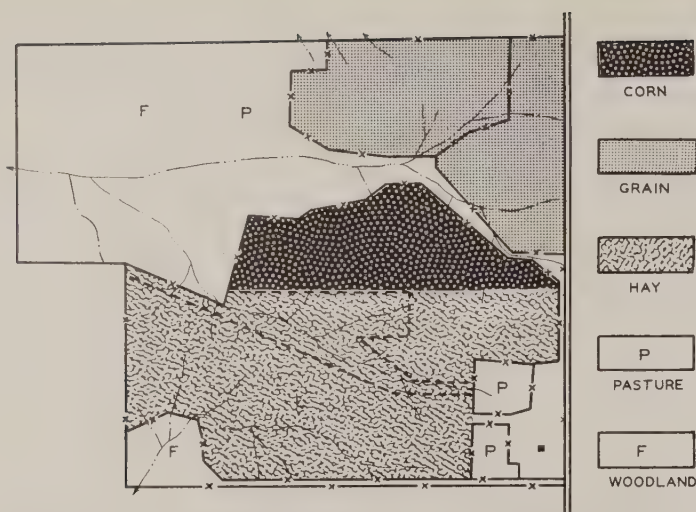


Figure 3.—“Before” map, showing drainageways, indicating very irregular slopes and farming without regard to topography.

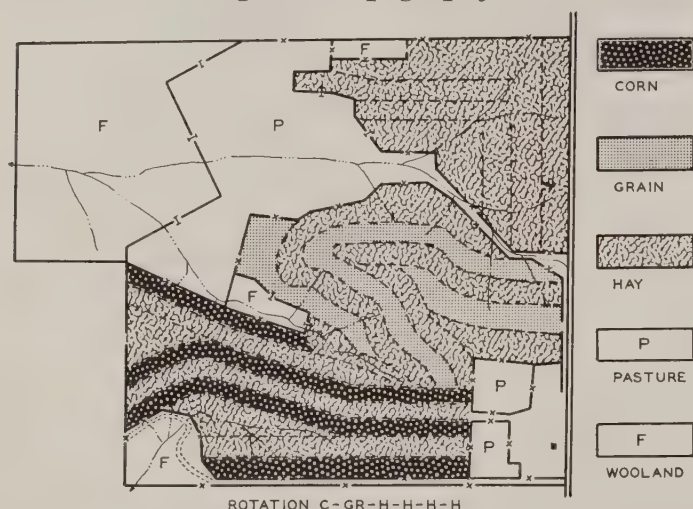


Figure 4.—Map of same farm after cropland has been planned in three field units of equal size, using a 6-year rotation of C-Gr-H-H-H-H. Each year all the corn will be in one unit, grain in a second unit, and hay in the third unit. Alternate strips of meadow between strips of corn or wheat afford adequate protection from erosion.

ing practices on some units than on others—terraces on unit 1, for example, so that one rotation can be used for all the field units on the farm. Buffer strips have been seeded between field units because they spread run-off water and facilitate contour tillage.

The question may be asked, Why is the farm planned in five field units, rather than four? The physical capability of this land answers the question in part, and the remainder of the answer came from the farmer. He wanted a large corn acreage and at the same time he wanted to reduce soil losses. If the cropland had been planned in four units, either of two rotations could have been used: (1) Corn-corn-grain-hay, which would have provided the farmer with necessary corn but would not have resisted erosion any more than his old plan; or (2) corn-grain-hay-hay in which case erosion would have been reduced but the

farmer would not have had sufficient corn. Therefore, by planning a 5-year rotation, the farmer has sufficient corn—40 percent of the crop acreage—and at the same time a rotation that will adequately reduce soil losses—40 percent in an erosion-resisting crop.

One other point also may be considered here. The farm plan is made so that a change in the size or shape of field units is not necessary if the rotation is changed. All that is needed is a change of crops within the rotation. Because farmers sometimes do not understand the value of rotations in a soil-conservation program, or because of insufficient livestock on the farm to utilize the additional roughage in more extensive rotations, or for economic reasons, rotations are often changed after the farm is planned. Such a change should not affect the general plan for the farm, but should cause merely an adjustment or a shift of crops within the rotation.

The 180-acre farm in figures 3 and 4 represents a different application of the same method of planning. No definite rotation of crops, or any particular attempt at soil or moisture conservation, was made by the farmer previous to his cooperation with the soil-conservation district. As shown in figure 4, some of the woodland previously used for pasture was fenced out to protect it from grazing; the cropland was divided into three field units of equal size. A 6-year rotation of corn-grain-hay-hay-hay-hay was planned, and strip cropping was followed. Because of the uneven topography in two units it was necessary to use field stripping. Contour strip cropping was used on the third unit.

The three units of cropland are more or less a natural division. All are easily accessible and workable. In this arrangement, each year one field unit will have corn and second-year hay in alternate strips, one will have grain and third-year hay in alternate strips, and the third unit will have alternating strips of first- and fourth-year hay. This provides for effective erosion control and at the same time makes it possible for the farmer to utilize the high percentage of hay in the rotation. One field unit can be used each year for summer pasture, while the hay for winter feed can be obtained from the meadow strips in the other two field units.

As in the case of the first farm, this plan is flexible in that the crops within the rotation can be changed at any time without any material change in the general farm plan. If, because of economic conditions, more grain is needed, wheat can be substituted for some of the meadow crops.

(Continued on p. 258)

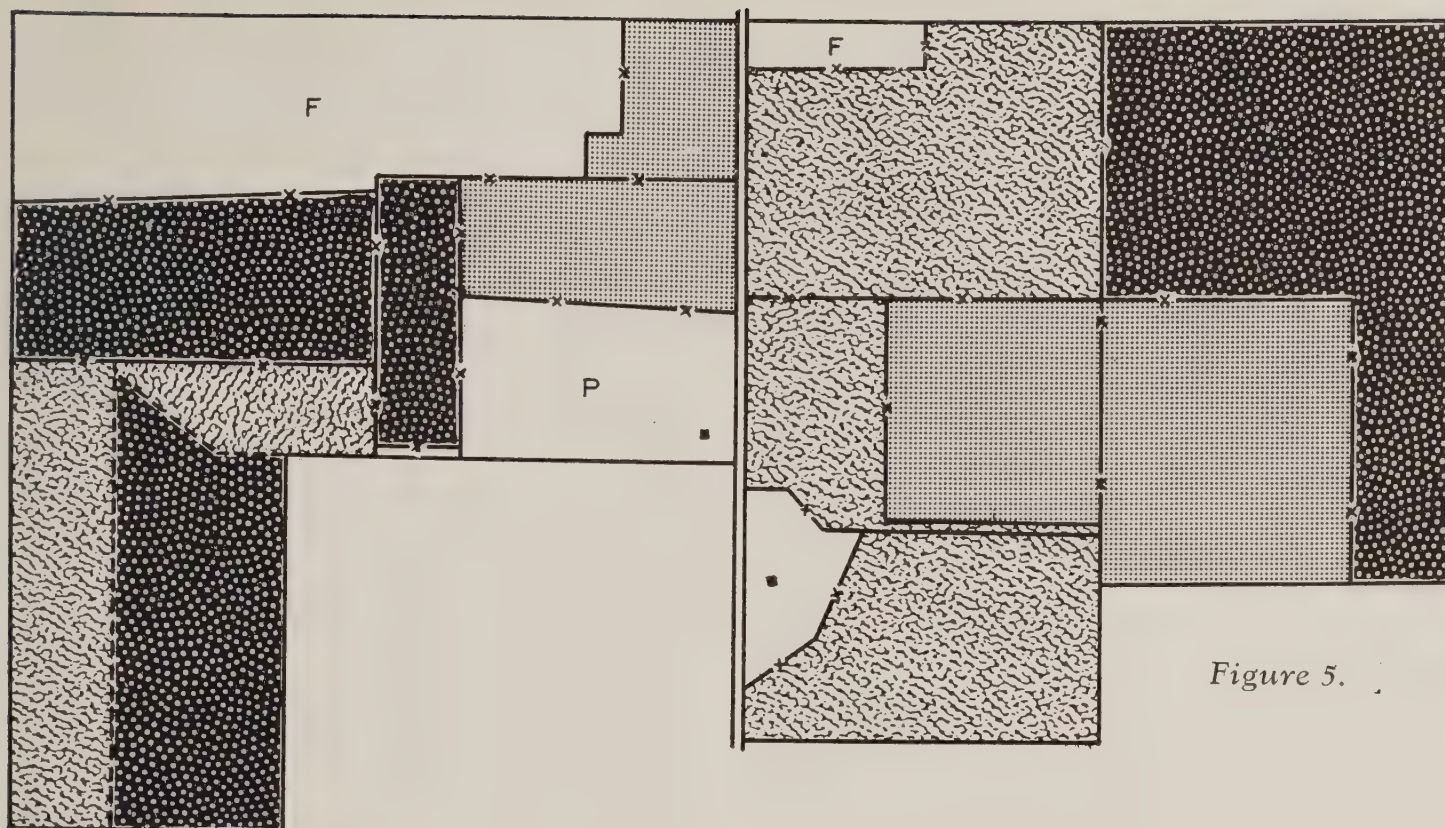


Figure 5.



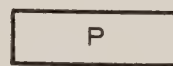
CORN



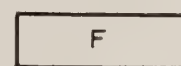
GRAIN



HAY



PASTURE



WOODLAND

Figure 5.—“Before” map showing dairy farm without permanent pasture, no definite rotation, and a field arrangement without regard for contour.

Figure 6.—Same farm, planned in three field units, a 5-year rotation of C-Gr-H-H-H with contour strip cropping. Field unit No. 1 is only half as large as either of the other two units.

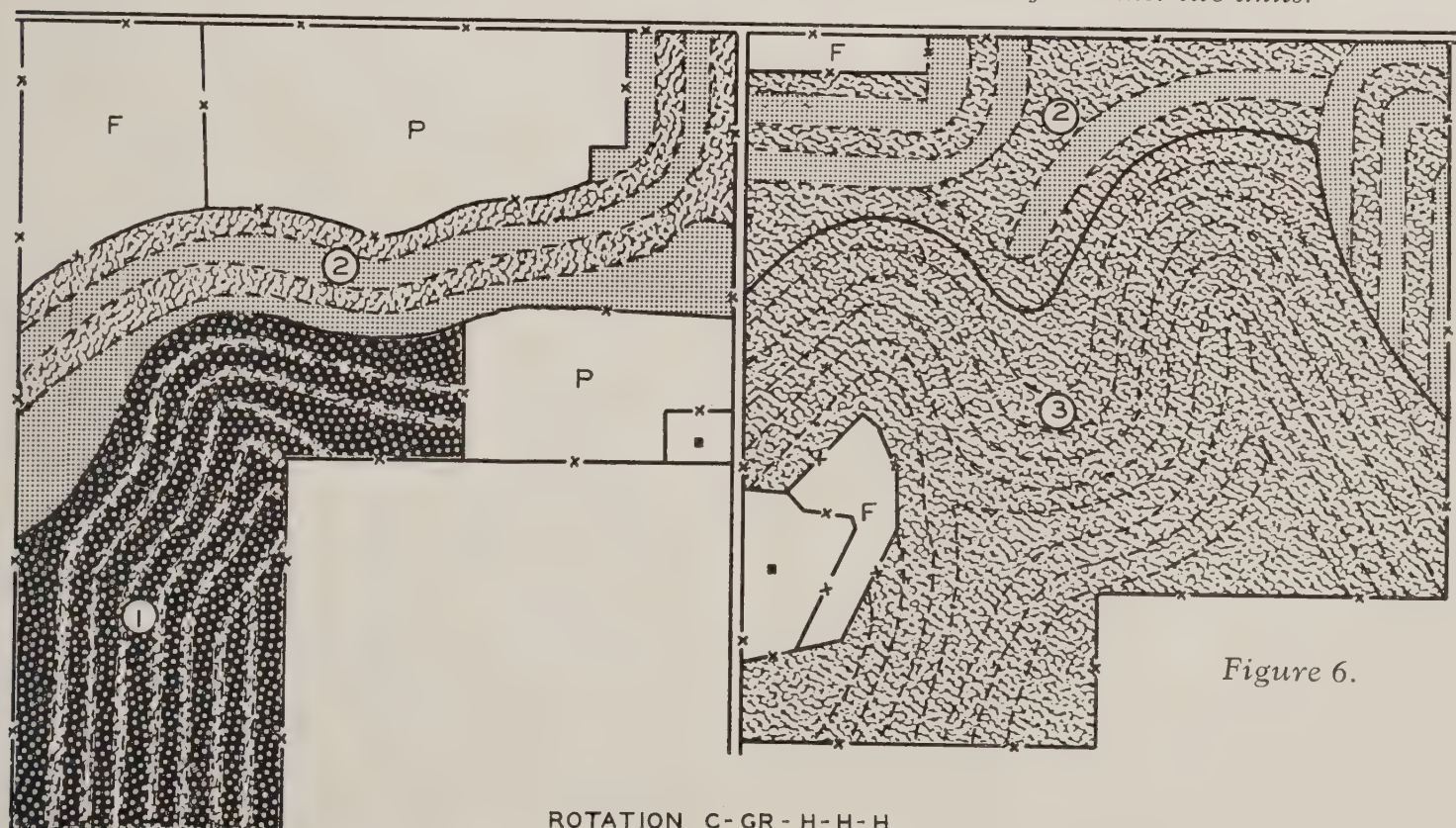


Figure 6.

ROTATION C-GR-H-H-H



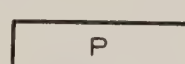
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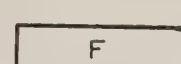
GRAIN



HAY



PASTURE



WOODLAND

FIELD UNIT PLANNING

(Continued from p. 256)

It is not always possible to plan farms so that the cropland can be divided into three field units of equal size. The 270-acre farm shown in figures 5 and 6 is an example. The owners recognized considerable soil losses and had difficulty in maintaining sufficient grass for summer pasture and hay for winter feed for a herd of dairy cows. It was being farmed in 14 fields without any regard to topography. When it was replanned 3 field units were established, one of which is only half as large as either of the other two. Field unit 1 is approximately 43 acres, while field units 2 and 3 are approximately 82 acres each. The rotation was corn, grain, and 3 years of hay. Field unit 1 will have meadow 3 years out of 5. In the other 2 years, when it is in corn or grain, these crops will be supported by contour buffer strips. The other 2 field units will be contour strip cropped, and the crops will rotate in much the same manner as the units in the second farm described.

The following charts show the sequence of crops in two rotations by field units and strips with approximate acreages:

Field unit	Strip	Rotation C-Gr-H-H-H-H					
1 ¹ (31 acres).....	A	C	Gr	H	H	H	H
	B	H	H	H	C	Gr	H
2 ¹ (34 acres).....	A	Gr	H	H	H	H	C
	B	H	H	C	Gr	H	H
3 ¹ (28 acres).....	A	H	H	H	H	C	Gr
	B	H	C	Gr	H	H	H

Field unit	Strip	Rotation C-Gr-H-H-H-H					
1 (43 acres).....	(²)	C	Gr	H	H	H	H
2 ¹ (82 acres).....	A	Gr	H	H	H	C	H
	B	H	H	C	Gr	H	H
3 ¹ (83 acres).....	A	H	H	H	C	Gr	H
	B	H	C	Gr	H	H	H

¹ Field unit with two or a multiple of two strips.

² Not strip cropped; supported by buffer strips.

In order to show the further flexibility, other than a changing of crops within the rotation made necessary by a change in the farm enterprise or economic conditions, let us suppose that one of the meadow seedings fails. A spring grain can be sown with a reseeding of the meadow. Corn will be planted again in regular turn even though the meadow failed one year. The crops in the other strips will continue to rotate in accordance with the general plan, since they were not affected by the seeding failure.

Not all farms can be planned in this manner. There are many variations, however, that can be used for peculiar conditions on particular farms, and the ingenuity of planners will determine how far this method will be used. It is especially applicable in soil-conservation districts where farmers do the

planning, where flexibility in cropping systems is essential to take care of necessary changes in the farm enterprise, and where simplicity is indispensable both for establishing and maintaining farm plans.

ELECTRIC POWER

(Continued from p. 254)

living in their vicinity. Typical examples are creameries, cheese factories, fruit and vegetable canneries, and woodworking plants. One of the most interesting is an alfalfa mill in the Brazos Valley near Bryan, Tex. Soil conservationists will be interested, perhaps, to know that since this mill was set up, alfalfa growing has become an important farm activity in what was for years almost wholly a cotton-growing region. The net effect of such development is to broaden the base of the farm community socially and economically.

R. E. A. systems, besides contributing to the well-being of their own communities, are performing institutional services of which the effects will be felt over a long period of time and far from the immediate locality. For example, the R. E. A.-financed Tuscarawas-Coshocton Electric Cooperative, in Ohio, provides current to operate electrical equipment used in the Ohio Watershed and Hydrologic Studies Station of the Research Division, Soil Conservation Service. Electricity is used for laboratory apparatus, for pumping, for meteorological recording devices, for the lysimeters, and for many other purposes. The contribution of R. E. A. to this soil-conservation-research undertaking is typical of similar contributions which the R. E. A. program is making to many other local, State, and Federal institutions— orphanages, hospitals, forest nurseries, fish hatcheries, airway light and radio beacons, N. Y. A. training centers, and C. C. C. camps, to mention only a few.

Experience has shown, during the nearly 6 years of the R. E. A. program, that electricity can be a valuable aid to the soil conservationist, as to all who are striving to improve the social and economic condition of the American farmer. It is now clear that, given suitable rates and conditions of service, electricity can pay its way on the small, family-size farm. To achieve the maximum benefits of high-line service requires a combination of research and education. New ways of applying electricity to farm operations must be found. Farmers served by the new lines must be shown how to take advantage of the opportunities for saving and profit already open, as well as of those that may be opened in the future. The job ahead is big; but, granted the continued cooperation of the various interested groups and agencies, it is not impossible.

A CONSERVATIONIST LOOKS AT CONSERVATION FARMING

BY HARRY C. DIENER¹

NEARLY half a century ago, a wise old professor of geology at Harvard University, Nathaniel S. Shaler, posed one of the most disturbing questions an American has ever asked his country. "It is now a question," he wrote in 1896, "whether human culture, which rests upon the soil, can devise and enforce ways of dealing with the earth which will preserve this source of life so that it may support the men of the ages to come." In fewer words, Shaler might have asked, "Is an enduring civilization possible on this continent?"

In general, it may be said that nature is the best soil conservationist we have known, while man is the poorest. Across the centuries, nature gives a covering skin of vegetative matter to the earth which is ideally suited to the soil and climatic conditions of any given locality. In and on the soil she develops a balance of plant and animal life—a cycle of growth, decay, and reproduction.

When man breaks this natural balance by clearing away trees, by plowing up grasslands, by exposing the soil to wind, rain, and sun, the whole character of the land radically changes. The organic matter in the soil oxidizes and gradually disappears. As a result, the soil structure tends to break down and becomes less porous. Water evaporates more rapidly, and more of it runs downhill to swell the streams; soil washes away with the water, fills lakes and streams with silt, and clogs low lands with colloidal material which disturbs natural drainage. In short, the very acts of clearing and cultivation set in motion a whole train of new land and water relationships; the natural balance is replaced by a downward spiral of ever-accelerating run-off and erosion. It is this cycle that Shaler had in mind when he wondered, 44 years ago, whether civilization and soil conservation are compatible.

Earlier in the history of man when population was sparse and requirements were few, nomadic peoples could subsist on the wild products of natural vegetative growth. But sometime back in the unrecorded past an unknown genius conceived the idea of clearing the ground surface, planting seeds in the earth, and growing crops of his own choosing. From that day to this, as civilization has developed, man has become steadily more dependent upon the art, the science, and the

business that we know as agriculture. Today civilization without agriculture is unthinkable; yet agriculture has contributed and is contributing powerfully in many countries toward the weakening and destroying of the basic land resource which is civilization's ultimate source of strength and life.

What is the answer? Is civilization on this continent inevitably a self-destroying process? Or can the ingenuity of man devise and enforce ways of solving this deeply disturbing paradox?

Attempts to control erosion in the United States are fully as old as the Nation itself. Washington, Jefferson, and other early leaders, who were farmers as well as statesmen, advocated erosion control and practiced it on their own lands. Throughout most of our history, there always have been a few farmers who perceived the dangers of soil washing and took active steps to prevent it. All too often, however, the end result was failure; and until recent years no definite attempt was made to attack the problem on anything like a Nation-wide scale.

In 1933, for the first time in our history, the Federal Government took cognizance of the soil-erosion evil when it organized the Soil Erosion Service in the Department of the Interior. In 1935 it was transferred to the Department of Agriculture, renamed the Soil Conservation Service, and given permanent status. In the 7 brief years of its existence, the Service has helped to bring erosion under control on many thousands of farms. Even more important, it has developed and fostered a new concept of conservation farming—a concept that holds real promise of providing an answer to Shaler's monumental question.

At the core of the Service's program is the idea of cooperation with nature. Realizing that a wholesale retreat to grass and trees would be economic and cultural suicide, the Service has nevertheless contended that we must go part way. We must approach nature's soil conserving efficiency as closely as possible and still provide for the needs of our human population.

This means that cultivation must be confined as far as possible to the level areas and the gentler slopes. It means that steep and erodible lands must go under soil-guarding cover of perennial vegetation. It also means the application of specific farming measures, such as contour cultivation, terracing, strip cropping,

¹ Head, Farm Planning Section, Soil Conservation Service, Washington, D. C.

and many other devices, as a substitute for the intricate system of checks and balances created by nature under undisturbed conditions.

The farmer cannot change soil types or climate, but he can so manage the soil as to preserve its productivity, moisture-holding capacity, and general usefulness in a large measure of permanency. Conservation farming *does not mean* returning to nature's original vegetative cover on the land; and *it does not mean* merely the introducing of a few isolated conservation practices. It *does mean* the coordinating of all available physical and economic information for the farm as a unit and treating every last acre in accordance with its needs and adaptabilities, the type of farming and the resources that are available to the farmer.

If the objective of securing good land use and proper land management is ever attained, it will be because the principles advocated are simple, clear, and easily understood by the farmers and others. What the farmer wants to know is how much of his farm he can safely cultivate and at the same time receive an adequate return in profitable crops; and what practices, measures, and soil amendments he needs to supplement the vegetative growth for good conservation.

Assuming that the ideal of a permanent agriculture is sound, agriculture must become a planned business. Each individual farm must be planned as a business unit for the best long-time production program together with conservation of farm resources in accordance with the farmer's managerial ability. All sound planning is based on a definite, comprehensive inventory and a broad knowledge of applicable controls.

In planning for erosion control, it is necessary to determine for each field the extent to which erosion has damaged the land by soil removal, the degree and length of the slope, and the capabilities of the soil type itself. No one of these factors in itself, or any other one factor, is sufficient to use as a criterion for readjustment of farming. The fact that Caribou loam is an excellent potato soil, for example, does not give any guaranty that such soil wherever found in its present condition, is capable of producing a high yield of good, marketable potatoes. With the topsoil gone through the effects of erosion, rebuilding is necessary to get even mediocre results, and the topography may have been changed to such an extent that additional use of the land in row crops will eventually cause washing away of the remainder of the soil. Likewise, slope alone would not be a good indicator of necessary conservation work. A 5-percent slope on a shaley soil might not be a serious erosion hazard, but this same degree of slope on a fine sandy soil or on a wind-blown

loess, would be an important factor in farming for good erosion control and moisture conservation.

The economic factors, likewise, are fundamental. The farmer should be, and in most cases is, sincerely interested in soil conservation. But at the same time he is in the farming business primarily to obtain an income rather than to conserve soil. If, then, a conservation farming program unnecessarily reduces his income or adds considerably to labor and inconvenience, he is not likely to become a wholehearted conservation farmer. A planned conservation program on a farm should take into account both the physical and economic factors which exist on the farm and the abilities of the farmer. The plan must be sound, practical, and understandable, and it must fit into ordinary farming methods. Each farmer, of course, is intensely interested in the welfare and longevity of the life of the country, but he is naturally more personally interested in his immediate present and future. All these facts must be considered in a conservation program.

Soil and moisture losses are not due to one or even a small number of causes, and no one remedy is a panacea for the ills. In the past the failures of certain mechanical erosion-control practices have taught scientists that no one practice is likely to be sufficient. If we had only to consider the physical control of water movement, or the holding of soil in place, we could develop controls that would be almost entirely effective. But the job is made more difficult and more challenging by the fact that each farm unit represents a business enterprise as well as a piece of land.

Adequate control of erosion is possible, however, if the farmer observes three basic tenets of good land use. First, there are only two groups of soils from the standpoint of use—those which can be safely cultivated, and those which should never be cultivated. Second, when soils which can be safely cultivated are used, they should be utilized in such a manner that satisfactory structure and fertility are maintained and wastage due to erosion is reduced to a minimum. Third, those soils which should never be cultivated should produce a continuous income in a well-managed program of grass production for hay or grazing; or they should be used for timber production; or to provide food and cover for wildlife on the farm. The farmer who recognizes these truths and uses his soils in this way is a conservation farmer.

Assuming that such a system is satisfactory, the lands considered suitable for cultivation present a varied and difficult problem. The types of crops, the crop rotations, the soil amendments, and the supple-

mentary mechanical measures must become a part of ordinary farm procedure. Furthermore, this farming procedure must lend itself to local conditions, and to the economic needs of the farmer.

Proper handling of cultivated land that is not fit for further tillage requires time, patience, and skill on the part of the farmer. As rapidly as possible, the farmer should revegetate these critical areas with a cover that is both erosion-resistant and economically valuable. Once the cover has been established, whether grass, trees, or shrubs, it should be managed with care so as to preserve its vigor and income-producing value.

Attempting to control erosion by the use of a single practice may be a waste of money; in fact, some conservation measures actually may do more harm than good unless fitted into a complete farm conservation plan in relation to other practices and methods of land use. For example, terracing alone, without consideration of land-use capability or crop rotation or disposal of surplus water, may cause failure of the entire system, with consequent loss and damage not only to the terraced land but even to adjoining fields. The introduction of legumes without proper attention to soil amendments may be a waste of money on seed. Merely designating an area of land to be retired from cultivation to pasture does not make it good pasture. Good grazing control, proper plant food, and careful management are all essential. The development of pasture or hay without planning for profitable utilization through livestock may also be an economic loss to the farmer.

The experience of the Soil Conservation Service definitely proves that lasting conservation benefits accrue only when a profitable use is found for each acre on the farm and when supplementary methods and practices become a part of ordinary farm work. The farmer must feel that phases of pasture management, such as controlled grazing, mowing for weed eradication, and fertilization, are as much a part of profitable soil use in pasture as having animals to utilize the grass. If summer and winter cover crops are necessary in orchards and clean-cultivated fields for soil protection and fertility maintenance, the farmer's cropping system must include them at the proper time. If mechanical measures are necessary on certain lands, they must become as much a part of the ordinary methods of farming the soils of those lands as is harvesting the crop. If woodlands already exist on the farm or if they are established as part of the conservation plan, careful management and systematic harvesting of the trees must become almost second nature with the farmer. Not until all erosion-control

measures, such as rotation, strip cropping, terracing, use of cover crops, contour cultivation, fertilization, liming, controlled grazing, and woodland management, become a part of the regular farming system *in the proportions that they are needed* does the farmer have a conservation farming program.

This flexible and many-sided style of attack on the soil erosion problem already has proved its efficiency and value. In hundreds of Soil Conservation Service demonstration areas and in dozens of farmer-organized soil conservation districts, thousands of farms that were formerly going downhill and steadily losing soil have been made safe and secure against the ravages of rain and wind. These farms are now more efficiently organized and operated than ever before; many of them are producing better harvests and better incomes; and nearly all of them are supporting a more satisfactory way of living on the land. No longer can there be any doubt about the feasibility of controlling soil erosion.

During the past 7 years, Shaler's question has been affirmatively answered, at least in part. We have already devised "ways of dealing with the earth which will preserve this source of life so that it may support the men of the ages to come." Whether we can effectuate these conservation methods over all our eroding lands, in time to "head off" and eliminate the growing danger at our feet, is a question for the future.

Farm account record studies are showing that under average conditions, soil conservation practices pay on farms of Soil Conservation Service cooperators. However, in the records there are many farms which do not pay. Why? The chances are that the increased production of better pasture and feed crops are being fed to inefficient and unprofitable cows. The Bureau of Dairy Industry has just reported a study of a year's records kept on 675,000 cows by 28,000 members of Dairy Herd Improvement Association. Undoubtedly many of these dairy farms are in soil conservation districts. This study shows that the farmer keeping 18 cows that produce 200 pounds of butterfat each makes no more profit than the farmer keeping 10 cows producing 300 pounds of butterfat each. Think of milking 8 cows twice a day most of the year for nothing. Fewer and better cows can do a lot for soil conservation and make the work more popular with the farmers.



C. C. C. crews have planted about a quarter of a billion young trees in gullies and fields in need of permanent protection against erosion.

THE C.C.C.'S EIGHTH BIRTHDAY

BY G. H. GILBERTSON ¹

ON April 5, 1941, the Civilian Conservation Corps celebrates its eighth birthday.

On April 5, 1933, the President signed the executive order creating the C. C. C. Earlier that year, the President, conscious of two problems that seemed to complement each other, had conceived the idea of a new type of governmental organization. His thoughts went out to the thousands of young men who were out of work, in need of work. Those were depression days and there were no jobs. He thought frequently also of the condition of the natural resources of the Nation—wasting for want of man-power to halt the wastage and begin the program of conservation.

It may have occurred to the President that at the outset no new large administrative agency would be necessary—that perhaps 10 bureaus in 4 departments, all working together in one common enterprise under the coordination of a director and a small staff, could put the new program into action rapidly. A conference with the Secretaries of War, Interior, Agriculture, and Labor, the Director of the Budget, and the

Judge Advocate General of the Army, confirmed his thought.

On March 21, the President sent to Congress a message asking for enabling legislation. He said:

“* * * I propose to create a civilian conservation corps to be used in simple work, not interfering with normal employment, and confining itself to forestry, the prevention of soil erosion, flood control and similar projects. I call your attention to the fact that this type of work is of definite, practical value, not only through the prevention of great present financial loss but also as a means of creating future national wealth
* * *.”

Ten days afterward Congress passed legislation empowering the President to make use of any and all Government departments needed to put the program into immediate effect. On April 5, the President signed an executive order appointing a Director of Emergency Conservation Work to carry out the purposes of the Act of Congress. This was the beginning of the C. C. C., for the name Civilian Conservation Corps met with public favor to such an extent that

¹ Assistant information specialist, Soil Conservation Service, Washington, D. C.

Congress later substituted it for "E. C. W." The soil-conservation program we know today was yet to be born, but there is no denying the fact that the provision for camp labor in the Executive order constituted an initial recognition of the need for an active erosion-control program on the farms of the country.

Erosion control was a part of the C. C. C.'s work almost from the beginning, and the first assignment of camps to the Soil Erosion Service, then just starting an emergency program as an agency of the Department of the Interior, came in April 1934. This was an allocation of 22 camps. Soon after April 1935, when the S. E. S. became a permanent agency of the Department of Agriculture and was renamed the Soil Conservation Service, the apportionment of camps was raised from 51 to 204.

The number of C. C. C. camps directed by the Soil Conservation Service has varied along with the total number of C. C. C. camps operated by all cooperating agencies. The peak number of soil-conservation camps was reached in September 1935, when 500 were demonstrating the value of erosion-control farming practices to the farmers of the Nation. There was then a grand total of 2,427 C. C. C. camps. Since January 1938, the total number of all C. C. C. camps has remained at about 1,500. During most of the past year the Soil Conservation Service has operated 391 camps.

Since 1934 camps have engaged in soil-conservation work in 758 localities in 42 States. Work has been carried out on 20,000,000 acres under agreement with

the Soil Conservation Service, and today these areas are better able to withstand erosion because of the cooperation between farmers, the man-power of the C. C. C., and the technical services of the S. C. S. Viewed in the light of a demonstration of the effectiveness of erosion-control practices, the work on these 20,000,000 acres gains new significance.

Rough estimates of the number of different enrollees who have served enrollments in soil conservation camps place the total at more than a third of a million. Many of them were farm boys and as they return to farming they are able to put into practice the fundamentals of proper land use upon which the soil-conservation program is based. More than 1,100 former enrollees are now employed in the soil conservation program. They have learned their work from the bottom up, have ascended the rungs of the ladder one at a time, to regular jobs. The others, it is reasonable to expect, will in time mingle in almost every occupation. Their knowledge of the need of soil conservation will go with them to outposts otherwise beyond the reach of farming demonstrations.

Another benefit not to be overlooked is the training ground provided by the C. C. C. camps for the technicians needed in the growing soil-conservation program. Hundreds of employees in regional offices, areas, soil-conservation districts, nurseries, and elsewhere, received their initial experience in camps as superintendents, technicians, foremen, or as other members of the camp staff. Here, in contact with the

Possibly this generation will never fully appreciate what the C. C. C. is doing to build the internal strength of America. So many things of immediate magnitude are taking place every day that we are likely to overlook some of the long-time gains being made in our time. But the C. C. C. is making history, and as history is written in the future it will record that in the 1930's and 1940's the C. C. C. made an invaluable contribution to the conservation of America's most vital natural resource—its soil.

I doubt seriously whether the importance of the C. C. C. contribution to soil conservation in the United States can be overevaluated. Working under the direct supervision

of Soil Conservation Service technicians in camp areas throughout the country, C. C. C. enrollees have been the front line troops in the war on erosion. By providing the essential labor, they have provided added momentum to the conservation movement which today is reaching into the farming hills and valleys of the Nation—more extensively and more intensively than ever before.

On April 5, the C. C. C. marks its eighth birthday. It is an appropriate time for men and women in the Soil Conservation Service to recognize again the contribution of the organization that since the beginning has been working shoulder to shoulder with our own.—H. H. BENNETT.

workmen who plan and do the job in cooperation with the farmers who use the land, their experience has been practical rather than "bookish" and theoretical.

The C. C. C. has meant much to the conservation of natural resources; but these physical accomplishments represent only a part of its worth to the Nation. Time itself will serve to summarize the assets on the human side of the ledger.

Some of the Work Accomplishments of Soil Conservation C. C. C. Camps¹

Impounding and large diversion dams...constructed..	2, 074
Fences relocated to permit contour farming..rods..	13, 511, 843
Treatment of gullies:	
Check dams, permanent and temporary..number..	3, 444, 455
Gully banks sloped.....square yards..	79, 734, 349
Gullies seeded and sodded.....do....	369, 260, 642
Tree planting for gully control.....do....	351, 897, 116
Diversion ditches.....linear feet..	536, 706, 581
Terracing.....miles..	26, 648
Terrace outletting:	
Channel construction.....linear feet..	38, 177, 783
Outlet structures.....number..	333, 204
Planting, seeding, sodding outlets..square yards..	113, 034, 801
Sheet-erosion planting.....acres..	537, 708
Wind-erosion area treated.....do....	14, 174
Limestone quarried.....tons..	2, 094, 100
Land prepared for strip cropping.....acres..	187, 908
Contour furrows and ridges.....miles..	119, 497
Field plantings of trees, planted or seeded.....acres..	235, 843
Roadside erosion-control demonstration...miles..	686
Man-days assistance given soil-conservation nurseries.....	1, 737, 231
Drainage work:	
Clearing and cleaning channels and reservoirs	
square yards..	374, 009, 337
Excavation of channels (earth and rock)	
cubic yards..	66, 663, 182
Leveling spoil banks.....do....	11, 314, 099
Total man-days, all types of work.....	67, 738, 591

¹ From the beginning of operations to December 1940.

TOMBIGBEE-WARRIOR DISTRICT

(Continued from p. 251)

well established by years of tenure and by faithful service rendered. He can multiply the effect of his work many times by making a major portion of his contributions to groups rather than to individuals.

The county agent and his assistants can make a wider contribution by using organized groups than by dealing with individuals.

As to the work-unit technician, he can continue to show definite progress in farm planning and establishment of practices, provided he has the ability to use group action. By taking advantage of organized farm groups who are interested in the common problems and

who have proper local leadership, he can devote a small part of his time to assisting the groups with the establishment of seasonal practices, and still have the major part of his time for farm planning.

I see no particular reason why a group of farmers who have selected a capable leader cannot establish any of the recognized conservation practices in their community just as well as could an agriculturist, provided, of course, they have the assurance that they can obtain any desired technical help from the agriculturist when needed. By taking the initiative in this work and developing their confidence by doing the job, they will acquire the new methods and develop pride in the accomplishment. The latter development is most essential to the future progress and stability of agriculture. I have seen unassuming farmers beam with pride while a group of visiting farmers viewed their successful efforts in a conservation program. The enthusiasm of the visitors and their laudatory comments made the farmers who had done the work determined to continue their programs and to do a better job.

The various agricultural agencies can use the same organized groups to promote the different phases of the farm program. They might find need to use different leaders in order to take advantage of the abilities of particular individuals and, certainly, to give more people training in leadership. It is conceivable that the county agent would choose one leader to assume responsibility for certain phases of the program, the vocational teacher another, the Farm Security Administration supervisor another, and still another would be chosen by the work-unit technician. By proper assignment of duties and collaboration among leaders there should be no confusion, overlapping of responsibility, or lack of understanding of any programs. By using this method a community could take advantage of all organized assistance in promoting a conservation program.

Although thus far the results of group action in the program of the Tombigbee-Warrior Soil Conservation District are not entirely satisfactory, they do indicate gratifying progress and the possibilities for even greater achievements. The supervisors now plan to use local leaders to a greater extent for creating group-action interest in tours, field studies, the establishment of practices and, to some extent, in farm planning.

Let's share the new and good ideas developed in the districts! Short summaries are wanted by SOIL CONSERVATION.—Editor.

FROM THE ARCHIVES OF OLD VENICE

BY LOIS OLSON¹

BEFORE the dawn of written history farmers of the Ancient World had learned how to prevent soil erosion on their sloping lands. By the Middle Ages, Italian scientists had described the cycle of accelerated erosion and applied its principles to selected river basins. Leonardo da Vinci, a contemporary of Columbus, used these principles in his plans for controlling the flow of the River Arno and increasing the agricultural area of Florence. In 1601 and 1602, when the eastern United States was still a wilderness, Guiseppe and Girolamo Paulini recommended and presented in detail a coordinated program of erosion control and river regulation to be applied throughout all of the territory of Venice, under the supervision of authorities appointed by the State. This is the earliest known nation-wide program for the control of accelerated soil erosion. Venice was then a powerful nation, not merely a city at the mouth of the Po.

For over 325 years the plans of the Paulini lay buried in the archives of Venice. No other city in the world can boast as many historians as Venice, but none of the histories mention the Paulini or their program for soil conservation and river regulation. Until 1934, neither the letters nor the drawings that accompanied them were published.² No mention of them was made by English or German writers. In 1936, *Revue des Eaux et Forêts* published a brief French summary of the letters written by the Paulini in 1601 and 1602.

Guiseppe and Girolamo Paulini, the authors of the first two letters, were landowners in the little Serpentina Valley, a tributary of the Cordevole not far from its junction with the Piave. Before A. D. 1500 the surrounding mountains had been wooded and the valley prosperous. But now the Paulini were poor men—poor because the forests had been burned, the Serpentina had become a seasonal torrent, and the fields had been ruined by erosion and sedimentation. Although the Paulini could not afford to purchase better land, they were willing to pay for it with service. They offered to travel throughout the Venetian territory, wherever they were needed, to supervise the installation of their program of soil conservation



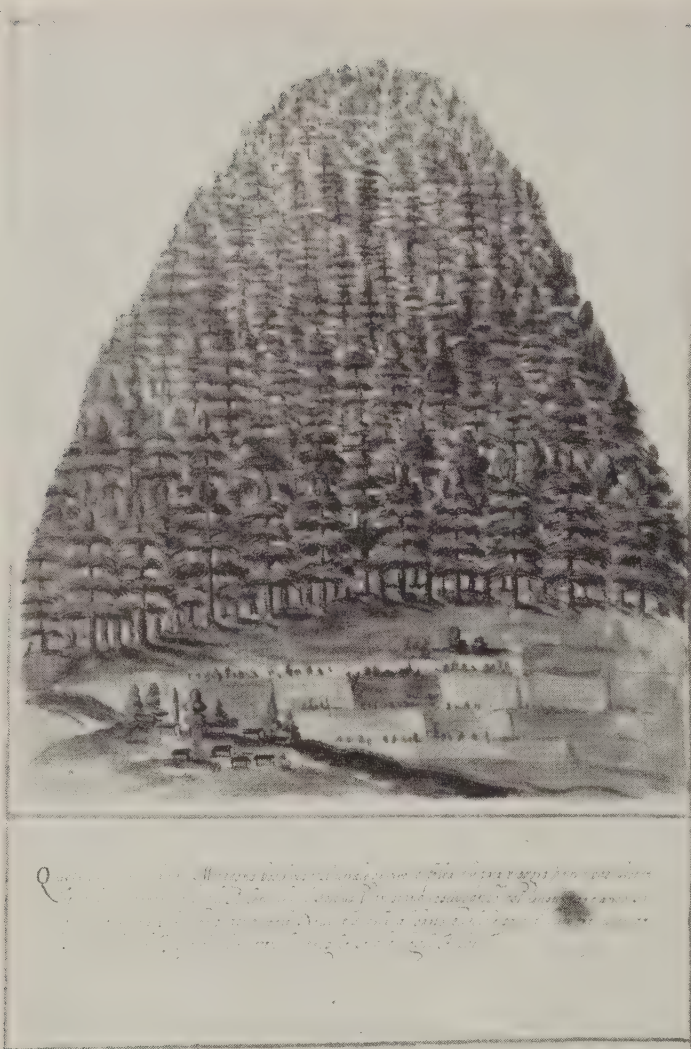
*"When a tree, a stump, or any other obstruction protects the land against heavy falls of rain or snow, the soil will not be ruined completely. * * * The water will be led gradually into the streams and, little by little, be absorbed by the soil."—The Paulini.*

and river regulation. In return they requested hereditary ownership of the fief of Fontanabuona in the province of Friuli, one of the best agricultural areas in Italy. There would be no other expense to the government.

The program of soil conservation was suggested at a critical period in the history of Venice. For centuries Venice had been the middleman for trade between Europe and the East; it was one of the wealthiest cities of the world. In 1453 a change began. The Turks captured Constantinople and trade with the East became more precarious. Fifty years later Vasco da Gama sailed around Africa to India and within another half century Portuguese trade with India was well established. Even Spain and her Italian rival,

¹ Head, Erosion History Section, Climatic and Physiographic Division, Soil Conservation Service, Washington, D. C.

² In 1934 the letters and illustrations of the Paulini were published for presentation to Mussolini under the title "Un Codice Veneziano del '1600' per le Acque et le Foreste" (La Libreria dello Stato, Roma, anno XIII, e. f.). Reviewed in *Rev. des Eaux et Forêts* 74: [168]-170. 1936.



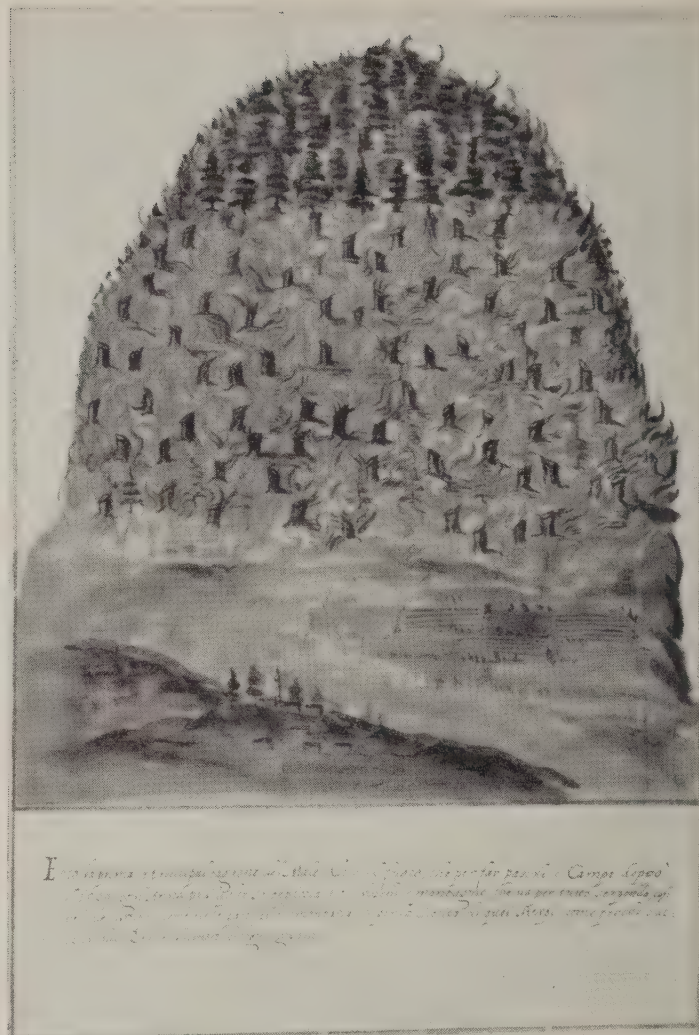
A wooded mountain.

Genoa, were better situated than Venice for trade with the East. For the first time, Venice began to take an active interest in the land.

In writing to the Council of Venice, the Paulini first explained that they had, with great care, worked out a plan for soil conservation and river regulation that would be of great benefit to the country as a whole. Although they offered Venice their services to supervise and initiate the program, the Paulini gave no indication of its nature or method of operation. The water authorities and administrators found the proposal worthy of consideration and wrote for further details.

Without delay, the Paulini sent a longer and more detailed letter, accompanied by about 20 drawings and paintings to illustrate the problems involved. The second letter is a short but masterly exposition of the causes of erosion, its relation to stream flow and sedimentation, and of the proposed control measures. They knew this would be a new type of undertaking for Venice, and the discussion is couched in the simplest of terms.

Of what avail, the Paulini ask, is the continuous



The mountain ruined.

dredging of rivers if the cause of silting is not removed? The mud and gravel are carried by waters descending with exaggerated liveliness from the mountains, which a hundred years earlier had been stripped of their vegetation. Before this, they continue, the rain seeped gradually through the ground litter of the forests and was stored in the soil. Trees shaded the snow and prevented rapid melting by the direct rays of the sun or by the hot south winds that blow from Africa. Now the forests are gone and the rain and melting snow flow madly off the hills, carrying with them sand and gravel. When the floods subside, the sediment is dropped. It blocks the rivers and prevents the flood waters from draining off naturally. In this way new swamps are formed on land that was formerly cultivated.

From their own observation the Paulini tell us that forest cutting causes little damage if new forests or cultivated fields replace the trees that have been cut to protect the soil. Burning is the root of the evil. Every year the Paulini have seen peasants in the mountains set fire to the vegetation in order to increase or renew their pastures. Fires respect nothing

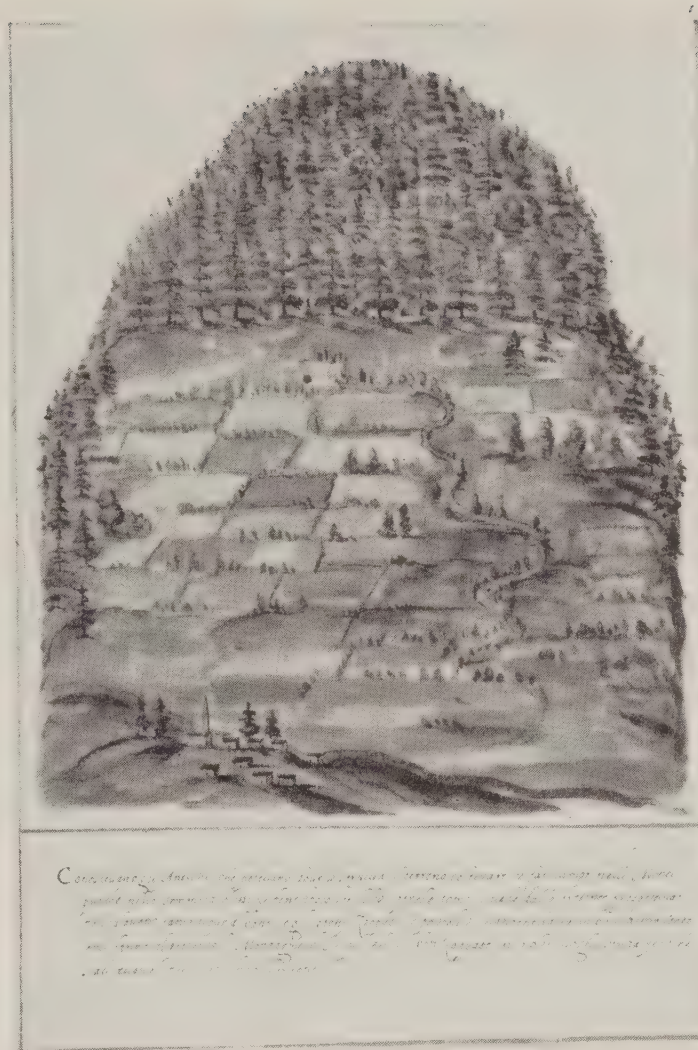
and worm their way everywhere, even into places too rugged for pasturing sheep. The soil departs and rock appears. When the floods subside new marshes are formed in the valleys and the finer debris may be carried as far as Venice. The councilors, themselves, can observe the large proportion of ashes and other carbonaceous debris in the lagoon deposits. This will prove to them both the cause and the source of the silting.

The illustrations tell the same story, but more vividly. They were the Venetian counterpart of "What is Soil Erosion?"³—a bulletin recently published by the Soil Conservation Service, in which the technical aspects of soil erosion are simply explained by photographs. But the Paulini antedated the Soil Conservation Service by more than 325 years. Theirs is probably the first series of illustrations ever drawn that shows the complete cycle of erosion and sedimentation and suggests methods of control for an entire country.

The first drawings show in color a single tree covered with foliage that intercepts the rainfall and the snow. Then the same tree is shown with little tongues of orange flame licking up the trunk and along the branches. After the fire, only the charred skeleton of the tree remains and the forest litter at its base has been completely consumed. The water now, the Paulini explain, rushes toward the valley, carrying with it the soil from the mountains.

The next series of pictures shows a hypothetical mountain covered with trees. At its base is a prosperous little village, a small stream, and neat fields, obviously cultivated horizontally. When the trees are cut, terraced fields, separated by hedges or trees, spread up the mountain side. A winding tree-bordered road connects these with the valley and on either side of it the land has been left uncultivated. Above the fields is a zone of pasture land, but the top of the mountain remains wooded. The stream at its base has grown a little broader, but the countryside is still prosperous.

When fires attack it, however, the mountain becomes a seething mass of flames that sweep across the lower slopes, crawl through the forest, and leap from the mountain top. No vegetation is left and the soil is exposed to the elements. The next illustration shows the result of repeated burning. In some places landslides have exposed bare rock; in others, sheet wash has ruined fields. Gullies have cut into the slopes, and sediment has covered some of the lowland fields.



The mountain saved.

A torrent has replaced the little stream and the houses of the village have become mere hovels.

The Paulini used first a single tree and then a forest-covered mountain to illustrate the relation between vegetation and erosion and water flow. After the principles are developed, they are applied to the Serpentina Valley, where the Paulini themselves owned land. First they picture the valley as it was before A. D. 1500, surrounded by wooded mountains. Then, for contrast, the valley is shown as it appeared a hundred years later. Herdsmen have set fire to the vegetation to improve their pastures. The fires have grown beyond control and all of the forests are aflame. Torrents, instead of streams, rush down the mountain slopes, carrying with them appalling amounts of sediment. Each grain looks like a boulder, but the exaggeration only emphasizes the carrying power of the water. Some sediment has been dropped along the stream courses, but more of it has been caught by the turbulent waters. Eventually it will find its way to the lagoons near Venice.

The Serpentina is used to illustrate the destruction that had already occurred in many of the mountain

³ Sharpe, C. F. Stewart: What is Soil Erosion? U. S. Department of Agriculture Miscellaneous Publication 286. 1938.

valleys surrounding the Plain of Lombardy. In order to reduce silting in the Venetian waterways, erosion must first be controlled in the higher lands. The problem is of national concern and cannot be solved by a single community.

Reforestation of the mountain slopes offered an ideal but not a practicable solution. It would limit too greatly the amount of farm land that could be cultivated. The Paulini recommended a compromise. If all burning were prohibited, the mountaintops would quickly cover themselves with a second growth of trees. Such areas were of no use for fields or pasture. On the cultivated slopes, ditches should be dug to distribute and retain the water until it had time to penetrate into the soil. Little soil would then be washed away and the moisture would percolate slowly through the ground providing the streams with a small but regular supply of silt-free water. On the valley floors, swamp land could then be reclaimed by confining the water in ditches bordering the fields and draining them into the rivers or into artificially constructed canals. How this work was to be accomplished is shown by diagrams.

The Paulini sent their plans to the Council of Venice early in 1602. For 6 years nothing further is heard of them. Then, in 1608, Guiseppe Paulini again wrote to the Venetian councilors, chiding them for their negligence. They had neither accepted his offer nor returned his plans. Possibly the Council was not entirely at fault. Guiseppe, apparently, had spent much of the intervening time in prison. Girolamo had either died or lost interest. His rights had been taken over by his Uncle Thomas. Venice, itself, was now in the midst of a long and bitter controversy with the Pope. The land had been forgotten.

Guiseppe, however, was still convinced that the preservation of the mountain lands and the regulation of the rivers was necessary for the welfare of Venice and he still wanted to own the estate of Fontanabuona in Friuli. He feared that the Council had considered the estate too generous a reward for his services. Venice was free to dispose of the estate because its last owner had died without an heir. Since then it had been rented to tenants. Although the rental was fixed at 1,000 ducats a year, plus a few other minor obligations, Guiseppe found that no tenant had ever paid more than 300 ducats. At this rate, he was asking very little in return for his services to Venice. Instead of retracting, Guiseppe suggested that Venice might well pay an additional 200 ducats a year to him and his uncle, jointly. The land, he said, had never been well cultivated and swamps detracted from its value.

The restoration of the estate, alone, would be a service to Venice, he implied. The reclamation of farm lands throughout the mountain valleys, the drainage of swamp lands, and the regulation of the flow of the rivers was an enormous task that the Paulini were willing to undertake only because they were "especially devout servants" of Venice. But they were poor men.

Venice, however, was more concerned about the controversy with the Pope and the activities of the pirates of the Adriatic Sea than about the land. Like its predecessor, the last letter written by the Paulini was never answered, nor were the plans returned. The program of soil conservation and river regulation was not undertaken during the lifetimes of the Paulini. Other countries of Europe adopted forest codes, like the famous French Ordinance of A. D. 1669, but none of those adopted within 200 years after the time of the Paulini express as clearly as they did the close correlation of forests and erosion with floods and sedimentation.

In A. D. 1600, Venice was one of the wealthiest States of Europe with prestige enough to defy even the power of the Pope. But the fall of Constantinople and the discovery of the sea route to India already foreshadowed her decline. A hundred years later Venice adopted a program of land and water control similar to that proposed by the Paulini, but by this time Venice had become a second-rate sea power with little influence upon the affairs of Europe. Other countries were unaware of her program of soil conservation. What would have been the effects of the same program if it had been adopted a century earlier by the powerful State of Venice, and how many acres of farming land, the world over, might have been saved from the ravages of soil erosion?

Farmers of the Morgan Soil Conservation District in the Weber River Valley of the Wasatch Mountains in northern Utah have some excellent irrigated pastures, and many new seedings have been made. While there is considerable bluegrass in these pastures, a large part of the forage consists of orchard grass and white Dutch clover. Excellent work is being done in seeding wheat grasses on dry eroded fields and in rebuilding the range by proper stocking. The Deep Creek area has made remarkable recovery since 1937. A cooperative bull association owning four bulls and operating within a radius of 15 miles helps to maintain the high quality of the farm herds.

RODENTLESS RODENT EROSION

BY R. M. BOND ¹



A "gopher burrow" type of gully on Anacapa Island, Calif., where no gophers, ground squirrels, or moles occur. The cracks in the dry clay soil are clearly seen.

BURROWING rodents, such as ground squirrels and pocket gophers, are frequently accused of causing gullies. Moles, though not rodents, are included in the indictment.

The theory is that when a burrow runs up and down the slope, water flows in at the upper end and out at the lower end, enlarging the burrow until the roof caves in, leaving a gully. In many parts of the West I have been shown such "rodent damage." When a small gully is found leading into or out of a tunnel, the evidence is regarded as absolutely conclusive.

It is, of course, very likely that burrowing mammals do cause some of this type of erosion, especially where they are abundant, but it is a noteworthy fact that the tunnel type of "rodent gully" is especially common in heavy clay soils where rodents are relatively rare.

Recently it was my good fortune to visit Anacapa Island, off the southern California coast. The island

has no pocket gophers, ground squirrels or moles, yet it contains many outstanding examples of what might be called, on the mainland, typical rodent-caused gullies.

The soils of the Anacapa Island range from a light-colored clay loam to heavy, dark clay, and appear to be dispersed. In the summer there is a very general formation of deep cracks and cross cracks down through the B horizon. Where surface vegetation is heavy the cracks are smaller and more numerous, possibly because of slower drying, and when the rains come these cracks close as the clay swells.

A number of years ago sheep were run on this island, and they largely or entirely denuded the soil of vegetation in certain places. Where the soil is laid bare, the cracks that have formed are long, wide and conspicuous. After the long rainless summer, usually about 4 months, during which the cracks are formed, torrential fall rains often occur. Then rainfall water runs into the interlocking cracks and downhill along their bottoms, sometimes for long distances. Often the water attains sufficient volume and velocity to cause considerable erosion before the clay can absorb enough moisture to swell the crack shut, and a tunnel is formed deep in the soil. Because of the dispersed nature of the material, the tunnel sloughs in and becomes increasingly large, maintaining always a roughly circular cross-section, until it becomes so large that the top caves in and a gully is formed. Many such tunnels were observed that were on the way to becoming gullies. One gully was roofed over (that is, the tunnel had not yet caved in) for a section 30 yards long, although it was open above and below the tunnel. Other gullies that must have started in the same way were 6 feet or more deep, and in places still actively eroding, though the sheep had long since gone from the area.

There are many areas on the mainland with similar climate and with soils that are susceptible to this same sort of tunnel and gully formation because of their physical or chemical nature. It is in just such places that rodents have the blackest reputations as erosion producers, though the evidence from Anacapa Island (and less conclusive evidence from the mainland, too) would seem to show that destruction of vegetation or other misuse of the land by man and his domestic animals is more generally to blame.

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RANGE SEEDING BY AIRPLANE

BY F. A. MARK¹ AND J. R. ROAF²

IN November 1939 the Soil Conservation Service seeded some 2,500 acres of Forest Service range land on the Squaw Creek demonstration project in Gem County, Idaho, for the purpose of reestablishing desirable vegetation.

The topography of these range lands is rough and mountainous with elevations of 3,500 to 4,500 feet. Pine and fir timber exists on the steep north slopes. The vegetation on the south and west slopes is made up largely of annual grasses, weeds and sagebrush with remnants of native bluegrass, bunch wheatgrass, fescues, balsamroot and other plants indicative of the virgin plant cover. The soils are of recent granitic origin. The slopes are mostly steep with sparse plant cover and hence very susceptible to erosion. An average annual precipitation of 21.4 inches was recorded at Ola, Idaho, from 1896 to 1906. This station is at an elevation of 3,100 feet, and is about 7 miles from the areas that were seeded.

Artificial revegetation of portions seeded was considered practicable because of the relatively high precipitation and potential productivity of the site as compared with other nearby sites that were seeded and observed over a period of years. With a proper protective cover it is expected that the area will be valuable for range forage production, will serve as a means of conserving water and controlling flood, will provide a habitat for upland game including deer, birds, and fish, and can be used to a limited degree for timber production.

Because of the inaccessibility of the areas, it was decided that airplane seeding was the most effective means of broadcasting the seed. The flying firm prepared for the job by reconstructing the interior of a 220-horsepower, 3-place cabin plane to allow room for a hopper with a capacity of 500 pounds of seed. Several test flights were made at the airport with the hopper loaded with sawdust, to study the operation of the hopper and the outlet. Then further test flights were made, using seed, on an easily accessible range area, and seed distribution was checked on long strips of muslin.

The actual seeding operations were carried out by flying at a height of 300 of 500 feet, so that the seeds



The inside of the seed hopper had capacity for 500 pounds of seed. The pilot used the rope control in the center to regulate the distribution.

were distributed in a swath about 100 feet wide. The flight lines used were about 100 feet apart and the areas were cross-seeded to assure adequate distribution. A ground inspector indicated the flight lines to the pilot, checked the distribution of seeds and flagged the plane from the job when the winds scattered the seeds too widely. Seeding was most satisfactory from day-break to 10 a. m. and from 4 p. m. until dusk. The seed mixture consisted of 3 pounds of bulbous bluegrass to 1 pound each of crested wheatgrass and yellow sweetclover. A total of 5,875 pounds of seed was broadcast from the plane which was loaded 11 times. The 10 hours of flying time were distributed over 3 days, November 5, 6 and 7.

For checking distribution of the seeds, 45 greased cards had been placed diagonally across a part of the area before seeding was started. These cards varied from 1 to 2½ square feet in size and totaled 67.54 square feet. They were placed about 135 feet apart. After the seeding operations had been completed, the seeds adhering to the greased cards were counted and recorded by species and, from the countings and records, calculations were made to determine the mean number of seeds of each species per square foot, based on the pounds of seed used and the size of the area seeded. The number of seeds to the pound was determined by counting and weighing representative samples. Further calculations were made to convert the recorded number of seeds per card to seeds per

(Continued on p. 272)

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²Assistant range examiner, Mayfield Soil Conservation District, Pacific Northwest Region, Soil Conservation Service, Mountain Home, Idaho.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neill Faris

MANUAL OF CULTIVATED TREES AND SHRUBS, 2d edition. By Alfred Rehder. New York, 1940.

Probably the biggest job of the botanists and horticulturists is keeping up with zones of hardiness of the plants of the planet. Somebody carries a seed, a "slip" or a good-sized "shoot," from zone to zone, hemisphere to hemisphere—a hundred thousand somebodies and as many seeds—and thus are zones of hardiness altered continuously by man's economic and aesthetic activities and tastes. The reviewer remembers most vividly a young apple tree, flourishing deep in a cool moist pit in the soil of a Cuban banana orchard. The banana farmer had tasted *fritura de manzanas*, apple fritters, on board a ship from the north; he would grow *manzanas*, make his own *frituras*, have apple fritters every day for breakfast. It would be well worth another trip to the giant of the Great Antilles to learn the present status, or predicament, or the fate, of Juan Perez's apple tree in the terra cotta colored soil of Provincia de Camagüey.

Professor Rehder intends this second and considerably enlarged edition for horticultural use, and when one attempts to visualize the tremendous amount of work involved in compiling and recompiling such a volume, then one at least knows something about his idea of the importance to horticulturists of accurate descriptions and authentic climatic zoning of the thousands of species used throughout the continent for their economic and ornamental values.

The point of view is hardiness-limits, not identification, although it is possible to trace and identify varieties and hybrids and species by family traits. Actually the book constitutes a systematic and descriptive enumeration of the cultivated trees and shrubs found to be hardy in North America exclusive of subtropical regions. In this edition, the zones of hardiness have been reduced from eight to seven, and many species have been moved over old zone lines as the result of recent experimentation. The great scope of territory "zoned" by Professor Rehder can be appreciated to some extent by a study of the map of climatic zones in the front of the volume: Zone I takes in treeless Northern Canada with a -50° F. northern limit of hardiness; zone VII with a $+5^{\circ}$ to $+10^{\circ}$ minimum temperature, is the narrowest zone of all and swings as far south as New Mexico, Texas, and the Mexican boundary.

Since other factors besides temperatures influence hardiness, such as soil, exposure, rainfall and humidity, air drainage and shelter, Professor Rehder has included in the descriptions many suggestions as to culture, economic and ornamental properties of the trees, shrubs, and vines of the continent. These suggestions, modestly called "helpful hints" by the author, include information as to soils preference, value for timber, ornamentation (winter flowers, bright pods, grace of growth, autumn color), value for fruit, rapidity of growth, wood durability, name history, detail of local climatic preference.

Plant fanciers are sure to be intrigued by the rarer vines and woody herbs; while plant specialists—botanists, horticulturists or nurserymen, or even the man in the field putting the seed or seedling into the ground—will most certainly find a wealth of information in this edition of an already justly famous book. As for the taxonomists, they no doubt will have strenuous objections to some of the changes in nomenclature and transference of names. Nevertheless,

Professor Rehder has made a valiant attempt to adhere to the existing and more or less accepted international rules of nomenclature. The fact that these rules require an immense amount of attention on the part of botanists the world over should not detract from the value to the practical horticulturist of this manual of trees and shrubs of North America according to zones of hardiness.

The Soil Conservation Service is a great user of plants, and there is little or no doubt that this new edition will be widely used by those whose duty it is to recommend and approve erosion control plantings for slopes, roadsides, woodlands, etc., throughout zones of hardiness III to VII inclusive. The descriptions, now rewritten and clarified, contain all available new knowledge concerning hardiness, and keys have been rearranged for clearer determination of relationships. The rarely cultivated species are described briefly and are appended to more fully described related species. Thirteen genera, 335 species, 220 varieties and 33 hybrids have been added to the section "Description of Trees and Shrubs," page 1 to page 900, inclusive.

Aside from an enlarged map of climatic zones, an excellent index, and the 900 pages of description, the volume contains sections explaining the abbreviations and signs used, a synopsis of Orders and Families included, an analytical key to Families and Aberrant Genera, additions and emendations, a glossary of botanical terms, and an explanation of authors' names as credited in the descriptions.

PUBLIC ADMINISTRATION AND THE UNITED STATES DEPARTMENT OF AGRICULTURE. By John M. Gaus and Leon O. Wolcott. Public Administration Service, Chicago: 1940.

Here is the Department of Agriculture in action—"one of the largest agencies of government in the world" thinking its problems "out loud" while undergoing a series of growing pains in keeping up with the needs of the times.

If the prospective reader is one of those in love with the routine mechanics of administration, doting on organizational charts and regulations, he should not request this book from the library. If, on the other hand, he is interested in such basic problems as production, distribution, land use, the quality of rural life, and the nutrition of the Nation—the fundamentals that lie behind mechanics in the Department—then here is a rare treat in store for him.

We in the Soil Conservation Service have a pretty good picture of how the Department's activities such as Farm Security, A. A. A., Rural Electrification, and the Extension Service operate "within the farm fence." As Gaus and Wolcott point out, however, that is only half the story. What goes on "outside the farm fence"—whether or not the problems of distribution and consumption with which other Department agencies are struggling are solved—may well decide the fate of our own work.

As the authors analyze the Department it becomes clear that it has assumed crucial responsibilities. Not only must the farmer and his land be protected by scientific production and management controls but improvement of the farmer's lot must not be at the expense of the consumer. The processor and distributor



BOOK REVIEWS AND ABSTRACTS

continued

also must be protected by fair standard regulations which the Department supervises.

Boiled down, the Department's struggle is a struggle against waste—the waste of labor, machines, and natural resources. "The many activities of the Department affecting production and the goals of production require the most careful integration if distortion is to be avoided. Here, in fact, is the crucial administrative problem of the Department."

Gaus and Wolcott are not cloister critics. Gaus, now chairman of Wisconsin University's political science department, has collaborated with Federal and State Governments on administrative problems for a quarter of a century. Wolcott, now secretary of the Commodity Credit Corporation, has been a lawyer, newspaper man, and research worker in the administration of natural resources.

While they like to discuss big issues and big names, they also show a surprising familiarity with the every-day problems of the field man in the local community. What ultimately happens in the local community is in fact their chief concern.

It appears from their study that the degree of coordination of the Department's many programs in the local community and region will ultimately decide the value of the Department itself to the Nation as a whole. In view of this fact, the authors are keenly interested in the soil-conservation districts and the local agricultural program-building and land-use planning committees.

If the people of the local community do really get together with

the Department's field personnel, trained in the many natural and social sciences, and assist in formulating and executing programs of production, distribution, land use, credit, and rural living on a scientific basis without waste, then the Nation as a whole will greatly benefit.

The chapter, "Land Use," is especially enjoyable reading for the person interested in land-use history in the United States and the philosophy which underlies the Department's work in that field.

As the Department's structure is analyzed, it consists of three interdependent branches of activity whose personnel is often interchangeable: (1) General staff, composed of Secretary, special assistants and bureau chiefs, whose job is to "feel the pulse" of the country, determine policy and coordinate the Department's activity at the top; (2) Line agencies, or the action services which execute the duties of the Department whether in research or in the field; (3) Auxiliary services, such as the Library and Office of Personnel which facilitate the work of the general staff and the line agencies. An excellent analysis of the activity of one of the auxiliary agencies, the Office of Budget and Finance, is contained in an appended chapter by Verne B. Lewis who was later employed by that Office.

While the authors state in their foreword, "This study is not a comprehensive definitive description of the Department," one does not finish the book without a very good picture of the way it is put together and what makes it "tick."—E. C. Higbee, Soil Conservation Service, West Salem, Wis.

RANGE SEEDING BY AIRPLANE

(Continued from p. 270)

square foot for each species. A study of the results indicates that more uniform distribution might have been obtained had the species been seeded separately, although the additional cost would not have been justified. Differences in the specific gravities may have caused some separation in the hopper.

Technicians examined a representative portion of the seeded areas on April 18, 1940, and found an average of about 10 new bulbous bluegrass plants to the square yard, the number varying from 2 to innumerable plants. No plants were found of the other species in the mixture. Both the germination and distribution of the bulbous bluegrass seed, as determined by this observation, are considered highly satisfactory. Previous experiences warn against passing judgment on the establishment of the other species until a few years have elapsed.

The following recommendations and suggestions, developed during these seeding operations, are presented to assist in conducting future seeding from airplanes:

1. The cost of seeding was not excessive for this area and should be considerably less for larger areas or areas having less broken topography.

2. An adequate site analysis should be made to determine suitable species and possibilities of obtaining a forage-producing and erosion-resisting cover commensurate with the cost.

3. Provisions should be made to protect the seeded area from livestock until the new plants are well established.

4. Suitable base operations should be located in the vicinity. They should include landing field and means of protecting the plane and supplies from livestock and weather.

5. Provision should be made for the ground crew, both on the area to be seeded and at the base of operations.

6. Cross-seeding is recommended only when a full stand in the shortest possible time is desired, as in revegetating burned-over watersheds above municipalities or other valuable areas endangered by severe flood hazards.

7. Agreement should be reached regarding the minimum requirements for distribution of the seed as a basis of checking the distribution by the number and size of greased cards. The cards used in this seeding are considered to be too small. Cards 1 yard square probably would be adequate.

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Compiled by **ETTA G. ROGERS, Publications Unit**



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¹ Issued for use by personnel of the Soil Conservation Service.

² From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.



clovers rank high among legumes used to conserve soil. They provide soil-building green manure, nutritious hay, excellent pasture, and soil-protecting cover crops. Red clover outranks even alfalfa as the most widely used leguminous crop plant in America. Clovers also have a high ranking wildlife record, more kinds of wildlife feeding upon their seeds and succulent leaves than upon any other group of legumes. Red clover alone is eaten by 22 different animals, white clover by 28, and all the clovers together by more than 100 birds and mammals. They are preferred foods of the cottontail rabbit, prairie sharp-tailed grouse, California quail, and the familiar bobwhite. - *Edward H. Graham*



MAY 1941

Noted in This Issue

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Progress in
Soil Conservation Districts

Research Studies

Field Operations



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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WELLINGTON BRINK
EDITOR

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In a sand blow area in Ottawa County, Mich. See the article, "District Gives Blow Land New 95-Year Lease on Life," beginning on page 275.



Owners of land like this find it difficult to pay taxes.



Paling is used on sand blow areas to protect young pine plantings, explains A. M. Hedge in his article opposite.

SOIL CONSERVATION



CLAUDE R. WICKARD
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

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MAY • 1941

DISTRICT GIVES BLOW LAND NEW 95-YEAR LEASE ON LIFE

BY A. M. HEDGE ¹

AN HISTORIC step has been taken by directors of the West Ottawa Soil Conservation District in placing 1,436 acres of tax-reverted lands under a long-term, systematic plan of conservation and management. Land was leased by the district after it had been transferred to the county under Michigan's tax reversion act.

Like many other States, Michigan has been plagued for years with the perennial problem of what to do with tax-delinquent lands. Efforts to sell these lands for back taxes and penalties were fruitless in many instances because no bidders wanted the lands. Where such sales were made, to bidders who were interested, the new owners were no more able to make a living and pay taxes than the folks who had just lost the farms. Thus it turned out that the counties were faced with periodic tax sales on the same farms every few years, and the land meantime was becoming ever more useless because of mismanagement and abuse.

In 1937 the tax laws of the State were amended to provide that land that is tax delinquent for 3 years will automatically revert to the State. The owner is given an additional year in which to redeem his title by paying the taxes and penalties. Land that is not redeemed is handled in one of two ways, depending on its location in the State. North of a line approximating Town Line 40, and roughly separating the cut-over area from the agricultural and industrial part of the State, all reverted lands are placed under the jurisdiction of the State Department of Conservation. South of this line reverted lands are handled by a State real estate board created by the law. Ottawa County lies south of Town Line 40, and is in the area that comes under the jurisdiction of the real estate board.

The State tax law provides that the real-estate board shall advertise and sell lands certified as tax delinquent, to the highest bidder, provided the bid is enough to cover the back taxes and penalties. Lands that cannot be thus disposed of are appraised by the board and may be sold for the amount of these appraisals. If bids are not equal to the appraisal, the board may give title to any political subdivision of the State requesting the lands.

That is how Ottawa County recently came into possession of 1,436 acres. The law specifies that political subdivisions receiving land in this manner must dedicate it to public uses for a period of 10 years. The problem was one, therefore, of securing for this land an assured plan of conservation management over a long period of time and of guaranteeing, insofar as possible, that the management in future years would not permit conditions to recede to the status that caused the parcels to go tax delinquent.

To meet this problem the county supervisors decided to lease the land to the board of directors of the West Ottawa Soil Conservation District for an initial period of 50 years, with automatic renewal privileges for three periods of 15 years each, making a total of 95 years if the lease runs its course. Under the terms of this lease the district pays the county \$1 rental.

The district assumes full responsibility for development, improvement, protection and management of the land, collects all revenues and pays all expenses, causes a long-time plan of development and management to be prepared which must be approved by the county supervisors and the director of the State Department of Conservation before it is initiated. The county supervisors agree to cooperate in effectuating

¹ Chief, regional division of land management and institutional adjustments, Ohio Valley Region, Soil Conservation Service, Dayton, Ohio.

this plan by appropriating county funds to the extent they are available, supplying relief labor to be used on the land under the direction of the district, and lending to the district county-owned equipment when it is available.

The district is to report to the county annually on the progress of the plan and to account for all receipts and expenditure of county or district funds. When from these annual reports it becomes apparent that the district is making a profit from operating the lands, the county and the district are to come to a mutually satisfactory agreement as to what part of the profit shall be paid to the county as rental.

The land covered by this lease has little possibility of being profitably farmed. Much of it is blow sand that is not only unproductive but is a serious menace to adjacent agricultural land because it is continually moving with the wind. The first and most important problem, therefore, is to stabilize and fix these shifting sand areas. Technicians of the Soil Conservation Service are now assisting the district in the preparation of plans for the use of beachgrass, brush, and paling windbreaks, to be followed by reforestation. Trees for this purpose will be available partly from the nursery operated by the district, and partly by purchase with county appropriations. The State Forestry Department is also contributing some trees. The CCC camp located at Grand Haven will supply part of the labor needed for this improvement.

Not all of the land is shifting sand. On a suitable site the district plans to establish some transplant beds, thus increasing the capacity of their present nursery. One or two parcels are capable of being farmed if proper conservation practices are followed. On these farms complete conservation plans are being prepared, and they will be leased to farmers who will agree to follow these plans. Portions of still other farms are capable of being operated under careful conservation practices. These fields will be rented to farmers who will agree to follow the plans made by technicians of the Soil Conservation Service.

Several sets of buildings are to be removed and salvaged. Old neglected apple orchards are to be removed from 15 acres as a sanitary and disease-control measure. To produce needed revenue at an early date some Christmas trees may be raised and marketed. Improvement cuttings in existing timber stands will be made and the products of this operation will be sold as fuel wood, poles, or pulpwood. Revenue from these sources will be put back into improvement of additional acreage. In plantings made for sand fixation, various materials that will provide game

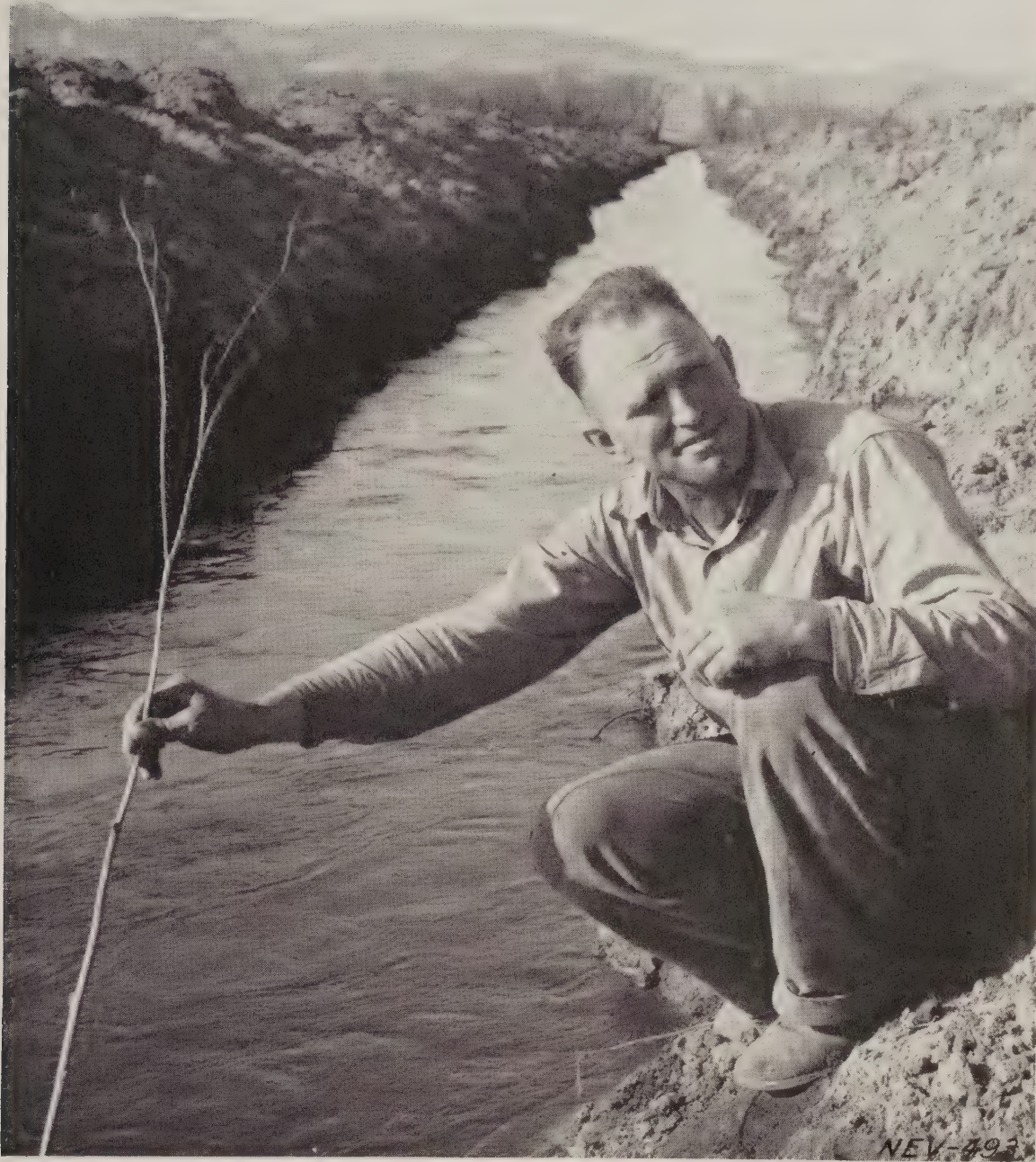
cover and food will be utilized. Since much of this area is near Lake Michigan it is thought that several sites will have definite recreational value, particularly when forest plantings have grown enough to give protection and enhance aesthetic values. These areas will be made available to the public on ground-rental contracts and private individuals may build their own summer cottages.

By this arrangement between the West Ottawa Soil Conservation District and the Ottawa county board of supervisors, a long-term plan of conservation management is provided for once chronically tax-delinquent lands within the district. These lands which under private ownership have failed to contribute their share toward the cost of local government will be improved and developed into a county asset; furthermore, after maturity of a timber crop on them, they may ultimately return to the county much more than they would if they had been left on the tax rolls. In the meantime their menace to surrounding good land will be removed and the county will not be faced with the necessity of finding, every few years, another unwary buyer for a piece of land that cannot produce its assessed taxes.

The Vernal Mesa Soil Conservation District near the Grand Canyon of the Gunnison River in western Colorado is tackling a tough erosion problem caused by slides on a steep slope above the main irrigation canal. Huge drifts of snow, as much as 25 feet deep, occur above the canal. When the snow melts and the water soaks down through the open soil to impervious layers of shale, the whole hillside begins to slide down. First a metal flume replaced the open ditch, built in 1905; later two 30-inch steel pipes were placed underground to carry the water through the slide area. Maintaining the canal at this point has cost as much as \$3,000 per year. In this district there is also another serious erosion problem caused by the waste water from potato and alfalfa fields.

Three hundred and sixty pounds of kudzu seed have been planted by farmers in the Piedmont Soil Conservation District in Alabama. These plantings were made with the idea of producing seedlings for use by growers and their neighbors in establishing kudzu meadows, waterways, and in retiring severely eroded lands to this valuable soil conserving plant.

KEY SPOT PROJECT IN NEVADA



C. O. Bastian, chairman of the Lincoln County, Nev., Land Planning Committee, referring to this ditch, says: "The S. C. S. job in Pahrnagat Valley has doubled the value of the three farms involved."

NEVADA'S small and scattered fertile valleys are sometimes called "land-use bottlenecks," and they are actually that, because regardless of how productive of grass the surrounding range may be a stockman cannot maintain a herd larger than his supply of supplemental feed—and this feed must be grown in the valleys. Surveys indicate that 50 percent of the livestock for the entire year comes from the valleys, which in area comprise but a very small fraction of the State.

The Soil Conservation Service program in Nevada is helping to keep these key spots, or land-use bottlenecks, in balance with the millions of acres of surrounding grazing lands whose value is dependent to a surprising degree upon the welfare of the valley lands.

Pahrnagat Valley in southern Nevada was first settled by the Mormons in 1870. Normally there are about 6,000 cattle and horses in the valley and on the surrounding range; and about 15,000 sheep use the range either as winter grazing or for "trailing" to other

ranges. The ranges are used during the winter and the valleys in the summer—this because the feed on the range dries up in the hot summer months but is at its best during the rainy winters.

On September 30, 1940, the Service entered into an agreement with the Pahrnagat Valley Soil Conservation District. The work plan specified that the Service provide a 1-cubic-yard power shovel and that the district furnish fuel, oil, grease, repairs, and an operator. The job involved the excavation of 9,500 feet of drainage ditch and 2,220 feet of irrigation ditch. The purpose of the drainage ditch was to carry excess winter rains from meadow land into Pahrnagat Lake and thus make available a large area for production of

summer feed. The irrigation ditch was intended to make it possible to irrigate alfalfa fields from the lake in dry summers. The ultimate objective of the project was improvement of supplemental feed production on approximately 1,245 acres of valley lands.

C. O. Bastian, chairman of the Lincoln County Planning Commission, recently remarked as follows to Albert Sanders, acting area conservationist in Caliente: "The Soil Conservation Service has just completed the job in Pahrnagat Valley which has doubled the value of the three farms involved. I know this because I used to farm one of the places myself, and if I were to buy it back today I would have to pay twice the price it sold for."—Charles D. Jarrett.

SOUTHERN NEW ENGLAND FERTILIZER CONFERENCE

BY A. T. SEMPLE¹

I. CONTRIBUTIONS TO GRASSLAND FARMING

IN THE United States there has been an unmistakable trend toward grassland farming since the First World War. Unprofitable crops, erosion difficulties, and the help of the action programs in agriculture have been responsible for a considerable increase in grassland, including both permanent and rotation pastures and meadow. To stimulate more interest in this movement, five regional grassland conferences were held last year under the auspices of the State experiment stations, extension services, and the United States Department of Agriculture. Since then a number of State and other regional meetings have given all or a major part of their programs to grassland problems. The seriousness of our national problem of protecting and rebuilding our soil resources and the severe contraction in our export market for cotton, wheat, and other crops, make it necessary that we convert a much larger acreage of our cropland to grass.

The conference held at Amherst, Mass., on March 10 and 11, to discuss new developments in the use of fertilizers, dealt principally with grassland problems. This was quite natural as about 88 percent of New England farm land is in pasture and meadow crops, and very few farmers have enough land or can afford to undertake production of the concentrated feed their livestock require. The principles of soil management and forage production apply in other parts of the country, however, much the same as they do in

New England, and for this reason some of the facts brought out at the conference are given here so that a larger group may benefit from them than was represented at the meeting.

Anyone interested in soil conservation or related problems is inclined to have a lot of confidence in what Professor Prince of the New Hampshire Experiment Station says; as an agronomist he is of the opinion that a good sod is a very good if not the best protection against erosion. He opened his discussion by indicating that true grassland farming involves the use of grass, including legumes for silage, without the production of corn or any similar cultivated crop. Since such grasses and legumes produce only about three-fourths as much dry matter per acre as can be secured from corn, it is obvious that the true grassland farmer must expect to use more fertilizers in order to increase yields sufficiently to care for present numbers of livestock. Professor Prince went on to point out some of the advantages of grass silage, stating that it is slightly better in feeding value than corn silage, pound for pound, and that the labor requirements for producing it are less per ton than for corn silage. With the increasing demand for farm labor to man the defense industries, there is bound to be less labor available for farm work. The lesser cost per ton has been proved by both the New Jersey and the Ohio Experiment Stations.

Changing entirely over to grassland farming involves some changes in the farm organization in respect to seeding practices, use of manure, and the

¹ Head, pasture section, agronomy division, Soil Conservation Service, Washington, D. C.



A good pasture gone wrong. Lack of fertility and organic matter in the surface soil has caused depletion of desirable pasture species and the incursion of brush. New Hampshire Agricultural Experiment Station.

kinds of fertilizers and the methods used in applying them. While corn for silage must be planted in the spring, as early as possible yet late enough to miss the late frosts, grass may be sown almost any time during the latter part of the growing season, after spring growth has been removed as a hay or pasture crop.

In the matter of handling manure, grassland presents quite a different problem from that of cropland. Dairymen have been accustomed to using rather heavy applications of manure on their cropland—30 to 40 loads per acre. Such heavy applications tend to be wasteful because of rapid decomposition and the loss of nutrients not used by the following crop.

Professor Prince pointed out that 10 loads of manure per acre is about the correct amount for top dressing of hay land. Records are in existence in northern New Hampshire of land that has not been broken since the 80's and is still producing 2 to 3 tons of hay per acre. This indicates the possibilities of permanent hay land if it is properly managed. Until very recently when some superphosphate was applied this meadowland had no treatment other than manure. As much as 20 loads should be worked into the land when it is broken to establish or re-establish a stand of grass. Even with such applications of manure, balanced with superphosphate, it may be difficult to maintain hay land on some of the lighter soils for more than 5 or 6 years. Accordingly, as a part of this problem of grassland farming, it is very important that the land-use capabilities of all soils on the farm be carefully considered.

At present, much land is being used for hay and pasture that would be much better off from the standpoint of erosion, flood control, and profit to the farmers, if it were in forest. Obviously, the acreage of better land, such as classes 1, 2, 3, and 4, which a farmer has available, would determine the extent to which he could convert classes 5 and 6 from pasture to tree production. Wherever better land is available, certainly there is nothing to be gained, either by grazing or by growing a hay crop on land with grass

so poor that it may pay to cut it but not pay to rake it up.

Professor Prince has under way a very valuable experiment to determine the relative values of (1) applying all of the superphosphate and potash necessary for a 3-year period at one time, and (2) dividing it into three equal portions and applying one-third of the amount each year over the 3-year period. The first 2 years' results indicate a considerable advantage in putting the whole 3-year treatment on at the beginning of the 3-year period.

In the discussion that followed, Professor Brown pointed out Connecticut Experiment Station records showing that land that will produce about 4 tons of dry matter in the form of corn silage will produce only about 3 tons in the form of grass silage with legumes predominating. With the true grasses predominating, the ratio between corn and grass would be considerably wider than 4 to 3.

These data from the Connecticut station answer the objections oftentimes made to a grassland program, that it threatens to increase livestock production to such an extent that it will have a bad effect upon the market. Even in the cases of cotton and wheat, about half of the crop is used for livestock feed in the form of cottonseed meal and hulls, bran, middlings, etc. There is little evidence to indicate that the grass being grown on land taken out of cotton and wheat, is producing as much livestock products as would have been produced by the cotton and wheat by-product feeds.

Changes to grassland will help livestock men by enabling them to produce meat and milk at lower costs per unit, since grass and especially pasturage is a cheaper feed than grain and other concentrates. In addition, the soil is maintained much more effectively where grassland has a big part in the production of livestock products. Some change in the distribution of livestock production is to be expected, and also some change from hogs to cattle and sheep, but the total production certainly is not adversely affected

and the market outlet is materially broadened because more meat and other livestock products are made available on farms that in the past have not had enough of this kind of food for home consumption.

Dr. Midgeley, station agronomist for the University of Vermont, gave a discussion of pasture and hay land management. He reemphasized the futility of attempting to apply fertilizers to lands of low water-holding capacity, such as sand hills, where water is the limiting factor in production. He showed how the taller-growing grasses desirable in hay lands, because of their greater yields, are rapidly killed out when they are grazed, just as they would be by frequent clipping. Of the tall-growing grasses, apparently only orchard grass is able to hold out under close grazing or frequent clipping. He emphasized the fact that adequate fertilization encourages their growth and makes it possible for them to shade out the turf-forming grasses that otherwise might decrease meadow production.

Dr. Midgeley also discussed nurse crops, pointing out that almost invariably the term "nurse crop" is a misnomer, in that it does not in any way help the young seedlings of the legumes and perennial grasses. In fact, it is often a detriment to them, since it causes them to make spindling growth so that they are killed if or when the nurse crop is cut off and only the bare stubble of the seedlings is left. About the only redeeming feature of a nurse crop is that it takes the place of weeds that might otherwise compete with the grass seedlings and thus supplies a crop of some value to the farmer's pocketbook. The cutting of the nurse crop is generally the last of it, while most weeds are likely to make some seed and continue as pests or competitors to the forage.

The possibilities of grass silage were discussed by Prof. C. H. Parsons of the Animal Husbandry Department, Massachusetts State College. He listed four advantages of grass silage in the preservation of crops:

(1) There is less loss of nutrients, since the material is put up green, and there is no loss of leaves and no loss by leaching such as occurs when rain or dew falls on grass while it is being made into hay. The moisture content of the green material should be between 60 and 70 percent, while that of material put up for hay should not be more than 20 to 25 percent. Obviously, about three times as much water must be handled in making grass silage as in making hay.

(2) In the making of hay, often there are odds and ends about the field, growth from shaded areas, hay not stacked for one reason or another, which can be

put away as grass silage and thus not wasted.

(3) Harvesting part of the grass in the form of grass silage makes it possible to get more of the crop harvested in the desirable stage before over-ripeness. When the crop is cut only in the form of hay, at least a third of the work time cannot be utilized in harvesting hay because of early morning dews, cloudy or rainy weather. Much of this time may be utilized to harvest grass silage, and in this way more of the crop can be harvested during the month of June.

(4) Grass silage may serve as a substitute for green pasturage during dry, hot periods in July and August. Putting up enough grass silage for a month or more of such midsummer feeding is more economical than depending on soiling—that is, cutting green crops daily and hauling them to the cattle.

In considering the labor requirements and the way grass silage fits into the farm organization in comparison with corn silage, Professor Parsons was reminded of the story of the three men who appeared at a railway station and asked how soon the north-bound train would be in. When the agent said in just a few minutes, they decided to cross the street for some refreshments. They returned and asked how soon the train would be in. When they were told it would be in any minute, they again crossed the street for refreshments. When they came out this time the train was just pulling out of the station. All dashed madly to catch it. Two got on and one was left behind, and he stopped and laughed at great length. Finally someone asked him why he was so happy about missing the train. He replied, "Those two fellows came down to see me off!"

Thus it is that what the farmer gains in one way, he may lose in another. While grass crops for silage require less labor than corn for silage, they may conflict with haymaking operations to such an extent that the farmer would be better off if he had some corn land as a source of silage in order to get a better distribution of his labor. Also, having both grass and corn as sources of roughage, he may be in a better position to get through the "bad" seasons when it may be too dry for grass or too wet for corn. Such inconveniences, in case the farmer is depending on grass alone, may be avoided however by carrying over grass silage or both hay and grass silage, from one year to the next so that he has a reserve for a poor season such as 5 or 6 weeks of summer with little or no rain.

An additional advantage of grass silage is its high carotene content, and also the high content of scorbutic acid. The flavor of milk is also improved by the use of grass silage. These are excellent selling points for dairymen who are in a position to market their own

milk and establish a reputation meriting some price premium for milk of high quality.

Professor Donaldson, extension agronomist of Massachusetts, noting that some of us were taking notes, tried to put a stop to it by showing a series of slides to illustrate the forage that may be used to supply an abundance of forage of high quality throughout the growing season. They appeared in approximately the following order, corresponding to the progress of the season:

- (1) Rye.
- (2) Hay land that has been top dressed.
- (3) Permanent pasture that has been fertilized.
- (4) Ladino clover for half-day grazing or night pasture, because of its extreme luxuriance of growth and high palatability.
- (5) Oats.
- (6) Alfalfa following the first cutting for hay.
- (7) Ladino clover on wet land for midsummer use.
- (8) A mixture of millet and Sudan grass, 15 pounds of each sown about the last of June.
- (9) Grass silage for droughty periods.
- (10) Rowen, following the first cutting of hay.
- (11) Orchard grass.
- (12) Early-sown rye.

The points he sought to emphasize in the pictures were as follows:

(1) Farmers do well to seed the kind of mixtures best suited to their types of soil, such as alfalfa mixtures on the well-drained soils, and mixtures including some Ladino for the moisture areas of the farms.

(2) Adequate top dressing of grassland is the most effective means of increasing longevity and productive yields. Farm trials have demonstrated that the tonnage of feed was more than doubled and costs per ton of the increase were less than \$5 per ton of dry material.

(3) Grassland crops should be utilized in accordance with the needs of the herd for feed. Grazing requirements should be met first; then hay or silage should be made from the balance.

In the discussion that followed, Brown of Connecticut cited the experiments at Rothamsted in which hay land has been top dressed for 98 years, and still satisfactory yields of hay are being obtained. He also pointed out that the Storrs Station has some evidence to show that the working in of phosphate and lime does not pay. In another experiment there is no significant response from potash on grazed plots, while hay plots over the fence will not produce a stand of clover without the application of potash. This is an example of how potash may be maintained much better on pasture than it is on hay land where the manure is

not returned or is largely wasted in the process. He emphasized that with as much as 50 percent of legumes in a hay or pasture mixture, there was little or no advantage in using a fertilizer containing nitrogen except to provide earlier feed, and certainly there was no advantage where the mixture consisted of as much as 75 percent legumes. The value of Ladino clover was emphasized by the statement that including it in a mixture of timothy and red clover increased the yield about one ton per acre over a 3-year period.

II. SOME FACTS ABOUT ORGANIC MATTER

IN ADDITION to his talk on grassland farming at the conference, Professor Prince was loaded with facts and figures on "the importance of organic matter." He showed how organic matter reaches its final stage of decomposition, that is, it is broken down until it becomes simply carbondioxide, water, ammonia, etc. This process may take several years, or it may come about with almost the speed of an explosion as in the case of crotalaria which at Gainesville, Fla., was observed to have disappeared completely within 6 weeks after being plowed under. He emphasized trying to increase the organic-matter content of soils above a certain level as a usually wasteful practice. This does not always hold true, however, as in the case of some soils formerly in forest and now being used for the growing of crops. A notable example occurs on the West Coast where certain soils now used as cropland contain about one-third more organic matter than the forest soils in their virgin condition.

For comparison of organic matter losses he cited the Ohio experiments, in which such losses from a 5-year rotation of corn, 2 years of small grain, and 2 years of clover and timothy, were slightly more than from a 3-year rotation of corn, small grain, and red clover. It appears that the more complete decomposition of the timothy in the grass mixture, resulting from a more limited supply of nitrogen, may be the explanation for greater loss of organic matter in the 5-year rotation. As J. B. Abbott pointed out later, when organic matter decomposes in the absence of sufficient nitrogen the decomposition may go further, with more CO₂ being liberated than if sufficient nitrogen is present to maintain a biological balance in the soil to hold nutrients that otherwise would be lost or made unavailable for plant use. Over a 32-year period in the Ohio experiments, the limed plots held more organic matter in the soil than the unlimed plots.

Professor Prince cited records kept at Blacksburg, Va., for work started in 1917 to show that on pasture



1938 hay crop, Livingston farm, Claremont, N. H. Land manured uniformly in 1936. NPK plots received 100 pounds of nitrate of soda, 400 pounds of 20 percent superphosphate, and 150 pounds of 50 percent muriate of potash. Hay yields over a 3-year period have averaged 4 tons per acre on the heavily fertilized plots, which is 3 times the yield from the check plot.

plots where 200 pounds of superphosphate had been applied annually, the surface 2 inches of soil contained 96 percent more organic matter than the untreated plot, and the next 2- to 6-inch layer contained 23 percent more organic matter. This increased amount of organic matter helps to keep the phosphate available by preventing it from becoming permanently fixed in the soil. It has been proved that where the soil contains adequate amounts of lime and organic matter, there is no serious problem of the phosphate becoming unavailable for use by the plants through permanent fixation in the form of iron and aluminum compounds.

He emphasized strongly that crop rotations alone are not sufficient to maintain the organic-matter content of soils; that lime, crop residues, manure, and fertilizer in varying amounts are also necessary. The larger yields incident to fertilization and the greater amount of crop residues including larger root growth, obviously are important in maintaining a desirable amount of organic matter in the soil. He pointed out the value of livestock in making possible a larger return of organic matter and plant food to the soil than in straight grain or other cash-crop farming.

In considering the value of rotations and legumes as one of the means of maintaining soil productivity, it is very important not to overlook the value of grasses, particularly the perennial grasses, in improving soil structure. This is emphasized in publications by Bradfield, formerly of the Ohio Experiment Station and now head of the Agronomy Department at Cornell, and Stauffer, of the Illinois Experiment Station. Stauffer's work shows that where crop residues and manure were returned to the soil, the organic matter was slightly higher than in permanent blue-grass adjoining the cultivated plots. However, the physical condition of the soil, as shown by the number

and size of the soil aggregates and the increased rate of infiltration, proved the value of grass in improving soil structure. The fact that under most conditions organic matter from grasses does not decay as rapidly as that of legumes is also an indication of the importance of including perennial grasses as well as legumes in crop rotations.

Dr. Abbott, a leader in agricultural research in the commercial fertilizer field, presented some very significant data covering a 3-year study at the Purdue Agricultural Experiment Station, to show the effect on crop yields on soils containing an adequate supply of phosphate and potash, of adding nitrogen to cornstalks at the time they are plowed under in the spring. The experiments conducted on Bedford, Parr, Crosby, Brookston, Miami, and Clermont soils, included plots in which the cornstalks were plowed under (1) without any nitrogen, (2) with 20 pounds of nitrogen per acre, (3) with 40 pounds of nitrogen per acre, and (4) with 80 pounds of nitrogen per acre. On Bedford soils, the increases in corn yields for the 3-year period, with 40 pounds of nitrogen per acre, varied from 3 to 17 bushels per acre; on Parr soil, from 9 to 16 bushels per acre; on Crosby soil, 7 to 26 bushels per acre; on Brookston (2 years), from 8 to 17 bushels per acre. Increases for Miami soil of from 5 to 12 bushels per acre, and for Clermont of from 10 to 25 bushels per acre were obtained from applications at the rate of 80 pounds of nitrogen per acre. The results of this investigation have not been published as the Purdue station wishes to get the results for at least 1 more year's work before drawing conclusions.

The available data for the different soil types, including the residual effect on succeeding crops such as soybeans, oats, wheat, and corn, following the season in which the nitrogen was plowed under with the cornstalks, showed an average net return per acre of \$4.41 for 20 pounds of nitrogen; \$6.40 for 40 pounds of nitrogen; and \$8.49 for 80 pounds of nitrogen. The cost of the nitrogen was figured at 10 cents a pound, wheat and soybeans at 75 cents per bushel, corn at 50 cents, and oats at 25 cents per bushel.

Dr. Abbott went on to say that green-manure crops grown primarily for the production of organic matter generally are rather expensive, considering the cost of seed, of planting, and the extent to which they interfere with the planting of other crops. However, in most instances they serve to protect the soil from erosion and to prevent leaching, thereby offsetting some of the objections to their cost as a source of organic matter. In contrast to the cost of green-manure crops, it is quite significant that crop residues,



It often pays to use some of the most productive land on the farm for pasture.

such as corn or cotton stalks and wheat straw, have no sale value and it may be said that they cost nothing to produce. If they can be made to supply organic matter satisfactorily, without interfering with crop production, and at the same time increase returns sufficiently to pay for the nitrogen necessary to facilitate their decomposition, then they constitute a very valuable contribution to the farm economy and soil conservation objectives. In the Indiana experiments, an expenditure of \$2 for 20 pounds of nitrogen returned a profit of \$6.40, at the prices cited above.

It was pointed out that, as in the case of cornstalks, when shavings such as those used for bedding, or any other highly carbonaceous materials are applied to the soil, they require an adequate supply of nitrogen and other plant nutrients for satisfactory decomposition and to avoid harmful effects on succeeding crops. The importance of having a well-balanced ration for soil micro-organisms, which convert woody material to humus, is clearly illustrated by the fact that hardwood sawdust derived from trees grown on rather fertile land decomposes much more rapidly than softwood sawdust coming from trees that have grown on very poor land.

In truck farming, where raw manure is rarely applied to the soil and composting is almost a universal treatment, the addition of some nitrogen as well as superphosphate to the compost pile appears to be a very desirable practice. The relatively small supply of manure now available for truck farming could be made to go much farther if the composting was done in the soil where it is to be used, provided adequate quantities of nitrogen were added to facilitate its decompo-

sition and to prevent its interfering with the growth of the crop planted after its application. The danger of losing nitrogen in the decomposition of manure can be avoided to a large extent by adding superphosphate, which tends to prevent losses by leaching or by escape in the form of ammonia and free nitrogen.

This discussion of the decomposition of carbonaceous plant material in the soil and the improvement of the process as a result of adding nitrogen is highly significant in connection with soil conservation. The use of nitrogen makes it possible to overcome the objectionable features of plowing under straw and cornstalks that might otherwise be burned, and in using such crop residues at or near the surface of the soil as a mulch to reduce run-off and erosion losses from both wind and water.

PASTURE MANAGEMENT

Improved pasture-management practices are reflected in conservation farm plans developed by the Soil Conservation Service. These include division of pastures to permit rotation grazing, fertilizing as required by specific soil types, stocking to capacity, deferred pasture use in the spring, clipping and mowing, spreading of droppings, and winter protection.

In the Pacific Northwest, development of upland areas for production of grass seed, and dryland pasture for use by young stock and meat animals provides for a better balanced use of rotation pastures by dairy stock in full production.

MATANUSKA FROM LAZY MOUNTAIN

BY W. A. ROCKIE ¹

IF ONE could take all the cleared land in the entire Territory of Alaska, draw it together into one solid block and have it transplanted, it would not cover more than one-eighth of the District of Columbia. Most of this cleared land is spattered over the upper portion of the Matanuska Valley, and nearly all of it is within 10 miles of Palmer. Thus Palmer is the present farming center of Alaska.

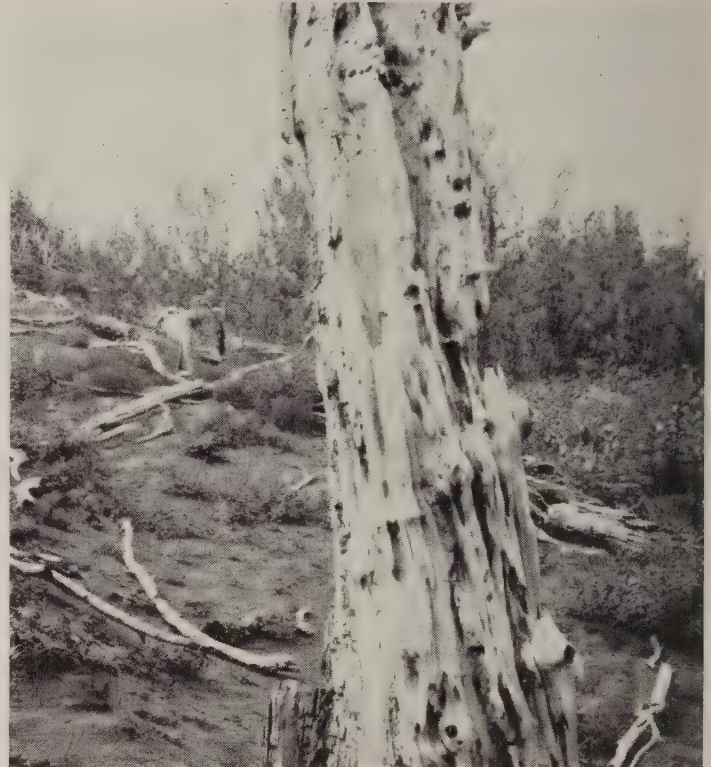
The Matanuska Valley still consists almost entirely of raw land. The Colony settlement, operating since 1935, and the homesteads taken prior to that time, if lumped together, would be only a "drop in the bucket" of the Valley.

Recently I climbed to the summit of Lazy Mountain, some 4,000 feet high. From this vantage point I could see the entire lower Matanuska Valley. Lazy Mountain lies about 8 miles east-northeast from the Palmer community center; yet, on its summit, one almost feels as though he could throw a rock southward into town, southeastward to the Knik Glacier, northeastward into the Matanuska coal mines or northwestward to the Willow Creek gold mines in the Talkeetna Mountains. Down the valley to the westward lie the lower Susitna Valley and Cook's Inlet, and beyond these one sees the western extension of the Alaska Range, about 75 miles distant.

Much of this landscape is hidden in clouds during the rainy late summer, but occasionally we have a clear day. The typical summer day here has frequent light showers with general cloudiness and hurried passing moments of sunshine.

On a clear day, from Lazy Mountain, one can see practically every farmstead and field. With the aid of binoculars he can watch the people of town as they walk from place to place, and to the east, in an inter-mountain valley, the community's band of sheep are pasturing.

On this particular day, a strong breeze from the southeast came down the Knik River Valley, bringing with it grayish-brown clouds of dust that swept for many miles westward and northwestward over this new agricultural center. These dust clouds are seen when strong gusts of wind strike the silt and sand bars in the mile-wide braided channel of the Knik River, lift the finer particles high into the air and spread the dust over the entire valley. The coarser particles are deposited along the timbered edge of the valley



Wind borne sand has blown away the softer portion of this dead tree trunk, Matanuska Valley.

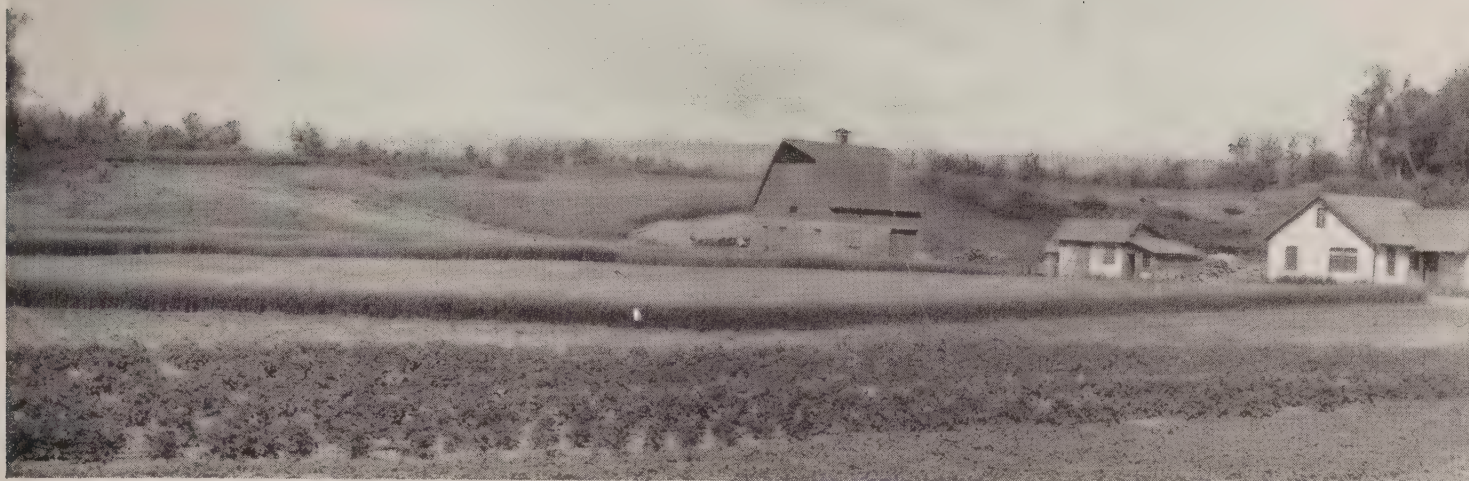
as a fringe of sand dunes. Between July 14 and August 7 of 1940 there were 9 days of "Knik dusters," or approximately 1 day in 3. A noticeable deposit of dust settled on the house furnishings in Palmer.

I have met many residents of the valley farms and have noticed that "hot days" are especially unwelcome to these folks. One particular group of people who had come in 1935 from the Lake States, where summer temperatures frequently approach and sometimes reach 100° F., remarked on the heat in the Matanuska Valley. At the time, the thermometer probably registered 75° or 76° F. In 4 years, they have formed a new standard for hot days—this particular day would have been very cool in the Lake States. To me, the temperature was delightful, while to them it was unpleasantly hot.

We are here to make a land-use survey of the valley. A detailed survey on the developed portions of the Matanuska Valley involves much the same procedure as does a similar survey in the United States. Already we have covered most of the developed lands so that, in general, only raw lands remain in the area to be surveyed. Virgin birch-spruce forests extend for many miles, without roads, without settlement, and with but few penetrating trails.

A reconnaissance survey does not require exact

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A typical Matanuska Valley farm home.

locations, but in a detailed land survey the surveyor must know his exact location at all times. Keeping the location accurate is a job requiring much effort, and experience aids greatly. The surveyor must do triangulation, run his land lines and measure his distances in a jungle through which he can see but a few feet and must slowly fight his way while running and measuring lines. Incidentally, he must locate the General Land Office survey corners established 25 years ago and all too frequently tucked away under a bed of "devil's clubs." Every minute of the time he is the center of a swarming mass of mosquitoes, gnats, flies, deer flies, and "no-see-ums." If he wears a mosquito net to protect his head and neck, he shuts off the cooling breeze, while if he does not use the net, the little "varmints" are continually getting into his eyes, nose, ears and mouth, to say nothing of their very efficient biting and stinging mechanisms.

These potential agricultural lands are a "Duke's mixture" of stream bottoms and terraces from both wind-blown and alluvial material, glacial moraine and outwash, lacustrine sediments, mud and gravel river flats, tidal flats and some rather limited areas of outcropping bedrock and of actively blowing sand.

Covering these lands are birch, spruce, and cottonwood forests, several kinds of grassland cover, sedge, and tule marshes. Over much of the land is a tangle of brush cover, commonly including one or more of these shrubs: highbush cranberry, red and black currants, alder, willow, rose, devil's club, silverberry, red raspberry, elderberry, and blueberry. Between and beneath these large plants grow herbaceous plants, large and small, and many smaller shrubs. Each of the many kinds of plants contributes its bit toward mantling this land with protective cover.

Rain falls frequently, so that the luxuriant grass and brush are almost always wet. Every movement in the brush provides an additional cold shower. There is only one protection—"tin" pants and coat, with rubber shoes. "Tin" clothes are made of the heaviest canvas, two thicknesses, with a weave so tight that neither water nor air passes through it. Since the grass and brush is always 2 feet and frequently 6 to 10 feet in height, its wetness is a matter of no small importance.

A good illustration of the weather difficulties of field work has been provided us by a group of movie photographers from "outside" who came nearly 3 weeks ago to take pictures requiring 3 or 4 days. They are still awaiting the 3 or 4 days. They have gone into the field, day after day, at 4:30 a. m., 5 a. m., 6 a. m., 7 a. m., 8 a. m. and later (for usually there is some sunshine in the early morning hours) only to be driven in by lowering clouds or rain about the time their stage is all set and ready to take. These folks are not in jovial mood at this writing.



Severe winds are already causing noticeable land damage in the Matanuska Valley. This grazing area has lost all its topsoil except where still held by the residual tufts of grass.

So much for some of the unpleasant aspects of the task we have undertaken. It also has some intriguing and inviting aspects.

The problem of proper land use here is one of which a few local people have some information and many ideas, but about which most of us know practically nothing. It is most interesting, therefore, to have a part in a study of these lands and their present and potential use. Our studies may aid materially in molding and guiding the future use of the lands of this valley.

The land forms and the soils are so young geologically and climatically that agricultural development should not be patterned after land development in the United States. There are no such soils in the States and it is therefore impossible to foretell what will happen to these Alaskan lands under agricultural use.

Since the soils of the valley are so immature, special problems as to the manner of their use are certain to arise—in fact, they already have been encountered. The soil blows readily and severe “blow” damage has occurred. There is practically no soil cohesion, and bare soil offers but little resistance to destruction by either wind or water. The prevalently strong winds indicate that protection from soil blowing must be carefully and continuously guarded. On the other hand, the usually gentle type of rainfall together with the low annual amount, and a generally gently sloping topography, would tend to indicate that soil washing

will not be a dominant problem in the area. However, in certain portions of the area where slope lands predominate, soil washing will unquestionably assume a greater importance than for most of the area with its relatively flat topography.

Agriculture has been practiced in the valley for at least 25 years. Some of the early homesteaders have been successful; others on similar homesteads have not. Some of the recent colonists are successfully farming their tracts, while others are not. The same was true of each of the present high-grade farming sections of the United States. Probably it has been true during the development stages of every region, even in the most favored land areas. No doubt pioneering sometimes failed on good lands largely because little or no information was available during the pioneer period as to the capabilities and limitations of the soils.

Alaskan agriculture must be patterned after and predicated upon experience in Alaska in the matter of land-use capabilities. Bringing United States farming methods to Alaska has been one contributing factor to those land-use mistakes that have already been made.

Since thus far so little of the land in Alaska has been cleared and used, it is possible that the wrong methods of land development and use can be recognized and discarded. At the same time, the right ways can be recognized and retained.

DEFENSE—FROM RIDGE TO RIVER

BY L. R. COMBS¹

FOR half a century McGregor, Iowa, watched heavy rains turn its streets into raging rivers. Flood waters in the main street sometimes reached a height of 6 feet, swept cars into the Mississippi, flooded stores and residences, and washed houses from their foundations. Usually the streets and sewers were filled with silt and rocks by even the minor floods.

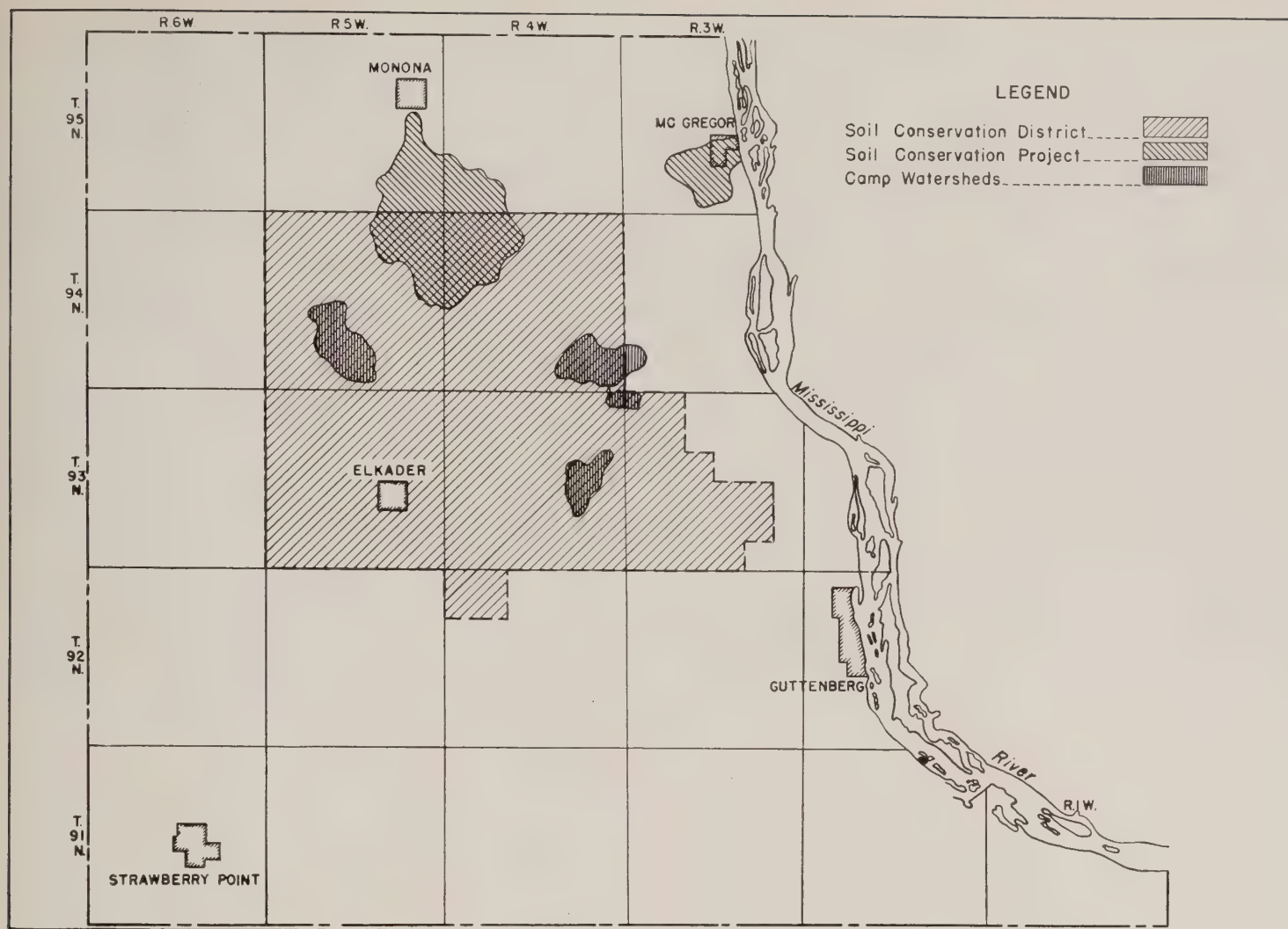
Today this Iowa town can tell a different story, because in recent years the farmers and townspeople, cooperating with the Soil Conservation Service and the Iowa State College, have built a permanent defense against soil erosion and floods. With conservation farming and detention dams, they now control run-off water all the way from the ridges above the town to the great river rolling along at its feet. A 5½-inch rain, one of the heaviest ever re-

corded, fell on July 26, 1940, and it did not flood the main street sufficiently to float a toy boat.

The McGregor-Farmersburg project area of the Soil Conservation Service includes the McGregor watershed of 2,250 acres and the Farmersburg watershed of 11,500 acres lying farther back from the Mississippi. This is the story of the McGregor watershed, the fan-shaped drainage area characterized by long, narrow, hogback ridges that break into steep rocky slopes and then flatten out into narrow drainageways or hollows. The town of McGregor, situated in the narrow outlet, long had suffered from flash run-off from this area.

According to records unearthed by Emerson Wolfe, formerly project engineer and now project conservationist, and other members of the local Soil Conservation Service staff, the village spent \$72,000 for cleaning streets and repairing sewers during the 29-year period ending in 1937. Private losses during this period are

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conservatively estimated by some of the older citizens to be in excess of \$200,000. For a village of 1,300 persons that is a considerable loss.

The first recorded flood damage was in 1866, about the time the town started construction of a storm sewer system. Other damaging floods were experienced in 1890, 1896, 1902, 1908, 1916, 1924, 1932, and 1934. One of the worst disasters was on June 20, 1908, when 3½ inches of rain fell in 45 minutes. Floods of less serious proportions have occurred within recent decades on the average of once every 2 years.

Damage to the village was not the only serious consequence of intensive rainfall over this area: Each storm washed tons of topsoil from the fields, cut large gullies in natural drainageways, damaged roads, and deposited silt and rock in roadside ditches and streams tributary to the Mississippi River. During 75 years of cultivation, the farm land of the McGregor watershed has lost approximately 60 percent of its topsoil. Some fields are ruined for agricultural production.

The McGregor-Farmersburg soil conservation demonstration project was established in the fall of 1935, and later the businessmen of the town of McGregor asked the project to assist in solving the local flood

problem. A committee of businessmen and farmers met with Service technicians and developed a 3-point program calling for the active cooperation of all interested persons and agencies. Briefly stated, the three points are as follows:

1. An extensive soil and moisture conservation program on agricultural land within the drainage area.
2. Construction of detention reservoirs to retard temporarily the excessive run-off from three of the larger hollows, using CCC-camp labor and materials furnished by McGregor.
3. Improvement of storm sewers by McGregor according to recommendations of Soil Conservation Service engineers, to assure proper handling of water discharged by the detention dams.

Thirty-two of the forty landowners in the McGregor watershed developed farm plans with the Soil Conservation Service. As a result, the cultivated land in the watershed has been reduced from 34 percent to 25 percent of the total and is largely protected by improved crop rotations, strip cropping, terracing, and vegetated waterways. Acreages of permanent meadow and protected woodland have been increased.



Mrs. Carrie Schriver, McGregor, shows her neighbor the damage done by flood waters in 1938 when the present land use and flood control system was just being started. The storm sewer was unable to handle the surplus water. Stores were flooded by 2 to 3 feet of water at that time.

McGregor has purchased 54 acres of timberland in order to protect it against grazing, and plans to buy more woodland as it becomes available.

Detention dams were constructed in Walton, West McGregor, and Siegele Hollows. These hollows have drainage areas of 385 acres, 415 acres, and 100 acres, respectively. Each earth dam has two reinforced concrete spillways. One spillway is a small conduit designed to permit a flow of water approximately equivalent to one-half inch of run-off per hour. The inlet of this tube is in the bottom of the reservoir and prevents the impounding of water except when the rate of run-off from the watershed exceeds the spillway's discharge capacity. The amount of water released through this outlet can be handled easily by the McGregor sewer system.

Large emergency spillways of the drop inlet type were built to guarantee safe operation of each dam under extreme flood conditions; they will be in use only during rains of rare intensity. These spillways were designed to discharge approximately 50 percent more than the estimated maximum run-off, or about 6 cubic feet per second per acre of drainage area.

All dams were built with 30-foot tops and 3 to 1 slopes on both upstream and downstream sides. These slopes already are covered with a good sod. Trash screens were installed to protect the spillways.

The reservoirs were designed to accommodate more than the accumulated run-off from a rain of 50-year frequency. In planning the construction, due consid-

eration was given to the effect of vegetative cover and erosion control measures on rate and amount of run-off. Run-off data obtained at the Soil Conservation Experiment Station at La Crosse, Wis., were used in estimating the run-off to be expected from areas devoted to different crops.

Construction work was started in the late fall of 1937 and continued, as weather permitted, until completion in August 1939. Labor was supplied principally by the CCC camp at McGregor. WPA and local skilled workmen were employed to operate certain equipment. During the 1938 season, a shovel and dump trucks were used for constructing the rolled earth fills of the dams, but tractor-drawn wheel scrapers used in 1939 proved more successful.

The Iowa Highway Department cooperated by relocating a half-mile of highway to permit the building of the Walton Hollow dam. The board of supervisors of Clayton County made possible the relocation of a section of county road over the West McGregor dam. The Iowa State Conservation Commission already has purchased about 132 acres of land adjacent to the town for timber and park areas.

In accord with its agreement, McGregor has improved the efficiency of the storm sewers by increasing the cross-section at certain points and changing some of the right angle turns to curves. Work of improving the sewer system will continue as village finances permit.

This combined program of improved land use, soil



An air view of the Walton Hollow detention dam, looking down the drainage area. The road across the top of the dam leads to farm houses in Walton Hollow.

and moisture conservation, and flood control proved its worth on July 26 by holding the $5\frac{1}{2}$ -inch rain. During a 12-hour period, the maximum rainfall recorded was 1 inch in 30 minutes, 1.7 inches in 60 minutes, and 5.1 inches in 12 hours. Although the last-mentioned intensity is greater than normally occurs in a 50-year period, the reservoirs were filled to only one-twentieth of their capacity and the storm sewers were no more than three-fourths full at any time during the 12-hour period.

In a small watershed it is the high intensity for a short period of time that usually causes the most

damage. The 30- and 60-minute intensities were only about 2- and 4-year frequencies respectively, so that the effectiveness of the program under high intensity for short periods is still to be tested. There is little doubt, however, that the run-off will be spread out and retarded even though it may cause the storm sewers to overflow slightly. As additional improvements are made and the storm sewers are enlarged, the danger of flood damage under extreme conditions will be still further diminished.

After the heavy rain of last July 26, it was observed that there was less damage on farm land under the



Typical of ridges around McGregor is this terraced field on the A. L. Henry farm.

conservation program than on nearby fields not so protected. Likewise, the smallness of the silt deposits in the detention reservoirs and storm sewers was evidence of the value of the land-use program and soil conservation practices to the watershed as a whole. There was no flood in the town of McGregor.

But in Marquette, just 2 miles up the river, old residents declared that in their town the water in Bloody Run Creek was as high as ever before, or higher. Officials of Clayton County, in which McGregor is located, estimated road damage at \$50,000, while damage to railroad lines was estimated at about \$10,000. Five highway bridges were undermined and numerous small culverts were washed out.

Residents of McGregor went about their business as usual the day after the rain storm. How different this experience from that of the past—no salvaging of damaged goods, repairing of property damage, shoveling of mud out of streets, storm sewers, and houses.

The reduction of flood damage and protection of soil in the little McGregor watershed are but part of the results. The McGregor-Farmersburg watershed, the demonstration work established by the McGregor

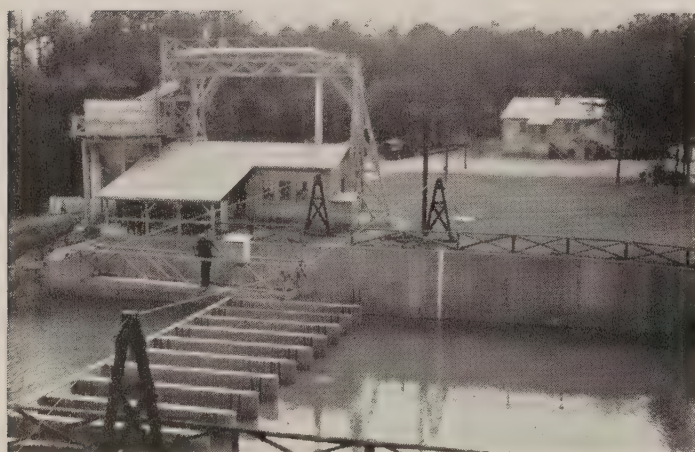
CCC camp, the work of an assistant extension soil conservationist stationed in a four-county soil association, the interest and activity of many local people, have effected a wide spread of conservation practices.

Most recent development was the organization in the summer of 1940 of the Clayton County Soil Conservation District, including five townships in the central part of the county. Ninety-three percent of the referendum vote was favorable. The McGregor watershed was not needed in the district because it lies in the bluff area along the Mississippi which is not primarily agricultural land. Interest was stronger in the more intensively cultivated areas back from the river. The district does include part of the Farmersburg watershed and some of the small watersheds developed in cooperation with the CCC camp. The keen interest in and around the McGregor watershed does indicate that its farmers will petition to be included in the district at a later date.

Summarizing this demonstration work: Residents of McGregor now sleep and work in peace, topsoil is tied down, run-off water is retarded, conservation farming is becoming more common, and a district is well under way in Clayton County.

THE TRANSPORTATION OF SEDIMENT BY FLOWING WATER AND ITS IMPORTANCE IN SOIL CONSERVATION

BY J. W. JOHNSON ¹



General view of Enoree River laboratory near Greenville, S. C.

THE erosive and transporting action of flowing water is undoubtedly the most important factor in soil erosion in most sections of the country. Essential, therefore, to soil conservation work is an adequate knowledge of the principles of transportation and deposition of erosional debris.

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From the standpoint of hydraulics, a drainage basin may be considered to contain two distinct erosion zones, each governed by a special set of principles and factors. These are (1) the zone of concentrated flow consisting of actual drainage channels, such as gullies, roadside ditches, streams, and flood plains, in which stream erosion is the major factor, and (2) the zone of more or less unconcentrated flow, constituting the remainder of the drainage basin, in which rain wash and sheet erosion are the major factors. To analyze the problem existing in the first zone, practical consideration must be given to the basic principles of erosion entrainment, and transportation of debris in definite channels. The problem of the second zone is one of evaluating the relationship of overland flow to soil characteristics, climatic conditions, slopes, and vegetal cover.

During the past decade numerous studies of the relation of erosion to the various factors of overland flow have been made on small plots. Recently somewhat similar investigations have been initiated on small

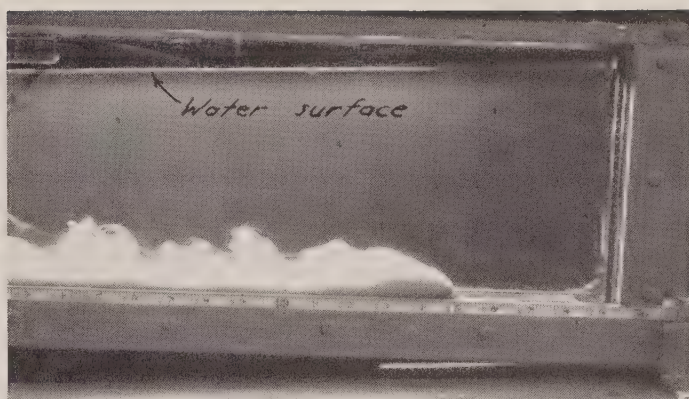
watersheds at a number of localities by the Soil Conservation Service. These very interesting and intensive investigations fall within the second zone and will not be considered in this discussion which is intended to treat only of the problems within the first zone, namely, the movement of sediment in defined channels.

In studying the transportation of sediment, separate consideration must be given to the two types of material being transported, the distinction between the two being based on the difference in the laws which govern their movement.² With the exception of dissolved matter, the total solids load passing a particular cross section in a stream may be classified either as bed-materials load or as wash load with a definite grain size representing the division between the two classes. The bed-materials load, or "bed load" for brevity, is that part of the total solids load which moves at a rate related to the stream discharge and is composed of the relatively coarse material (coarser than the dividing grain size). This material moves by rolling or sliding along the bed or by long jumps between points of contact with the bed while in temporary suspension. The wash load, on the other hand, except for a negligible percentage, moves in suspension at a rate which bears no direct relation to discharge and is composed of the relatively fine material (finer than the dividing grain size). The wash load provides much the greater part of the material in a suspended-load sample taken at flood stage and may be looked upon as sediment in relatively permanent suspension.

The grain size which divides the sediment load of a stream into two classes varies in different streams and generally throughout the length of a particular stream, although it has a definite value in a particular reach of a stream. For example, the dividing grain size in the Colorado River near Imperial Dam is 0.01 millimeter (fine silt), whereas in the Enoree River near Greenville, S. C., the size is 0.351 millimeter (medium sand). The dividing grain size can be easily determined from the mechanical analysis curves of samples taken from the bed of a stream immediately after a flood. It is the finest grain size that occurs in the bed in appreciable quantities (more than 3 percent on the Enoree River).

The amount of coarse material in movement varies directly with the stream discharge because enough of this material is available in the bed to load the flow to "saturation." On the other hand, the fine material bears no relation to the stream discharge because there is an insufficient amount of material to saturate the flow.

² H. A. Einstein, A. G. Anderson, and J. W. Johnson: A Distinction Between Bed Load and Suspended Load in Natural Streams. Transactions American Geophysical Union, Annual Meeting 21 (pt. 2): 628-633, illus., 1940.



A stream of heavier silt-charged water flowing beneath lighter water in a model reservoir. S. C. S. cooperative laboratory at the California Institute of Technology, Pasadena.

The available bed load (coarse material) in a stream system ordinarily changes slowly in composition during a long period of years, if at all, and the quantity of the bed load moved is mainly a response to discharge, whereas the wash load (fine material) may vary greatly from year to year and from season to season because of the changing conditions of supply which are independent of conditions of flow. The most important variables of these complexly interrelated conditions of supply are vegetal cover, tillage methods, stage of soil erosion, and climate.

In many small flashy streams almost all of the annual load of wash material is carried during a few days out of the year, and the content of wash material may vary many hundred percent within the period of an hour during the rising and falling stage of the stream. To date no method of wide applicability has been developed for estimating or computing with even approximate reliability the suspended load carried by any small stream; however, investigations of this important problem are now being made by the Sedimentation Division of the Soil Conservation Service.

The wash load is transported at practically the same velocity as the water and usually reaches a downstream point of deposition, such as an area of greatly reduced velocity on the flood plain, or in a reservoir, during the same flood in which the material was dislodged from its source on the drainage basin. The bed load, on the other hand, is transported at relatively low velocities, and moves comparatively short distances downstream in any single flood.

Observations made at the sediment-load laboratory near Greenville, S. C.,³ have revealed important information on the relative magnitudes of the two types of sediment load in a representative Piedmont stream. During the year 1939, 17,760 tons of sediment were transported in the Enoree River past the measuring

³ G. C. Dobson and J. W. Johnson: Studying Sediment Loads in Natural Streams, Civil Engineering vol. 10, No. 2, pp. 93-96, 1940.

station shown in the accompanying photograph. Of this amount 97 percent was wash load and the remaining 3 percent bed load. Although this ratio between the annual amounts of the two classes of sediment load is not expected to be the same for all streams, or even constant for the Enoree River, it probably represents fairly well the general order of magnitude for streams of the humid sections of the country where the supply of wash load available to erosional attack is essentially unlimited.

Sedimentation damage at various points in a drainage basin may be due to different types of sediment, possibly coming from different sources. For instance, flood and drainage damage caused by stream-channel aggradation appears to be primarily a bed-load problem involving the deposition of relatively coarse material. On the other hand, much of the material deposited in irrigation canals, normally constructed on lesser gradients than the streams which supply them, is very fine. Both fine and coarse material contribute to the deposits in reservoirs, but the finer grade of sediment (wash load) is normally more important than coarser grades because, as indicated above, it is carried in so much greater quantities. Because different types of damages are caused in different proportions by the two classes of sediment it is important that not only the total quantity of the sediment load of streams be determined, but also the relative proportions of fine and coarse material, in order that the principal sources of each type can be determined and effective remedial measures planned.

Although the bed load may constitute only a relatively small percentage of the total sediment load in a stream, practically the entire volume of all the coarse material will deposit as a delta on entering a reservoir. The fine material, on the other hand, may not deposit completely and some of it may pass through the reservoir either by general mixing and subsequent flow over or through the dam, or by passing along the bottom as a density current. In either case, it may be possible, under some conditions, to pass an appreciable amount of the fine material through a reservoir by operation of properly located outlet gates, whereas little or nothing can be done economically to remove the delta deposits of coarse material.

The phenomenon of density currents in a reservoir occurs where the heavier, silt-charged, inflowing waters of a stream flow under the lighter desilted waters already in storage. Because it is not easily discernible, its occurrence had been assumed to be rare, but recent observations indicate the opposite to be true. The high density of the underflow current may be due not only to suspended matter but also to dissolved matter

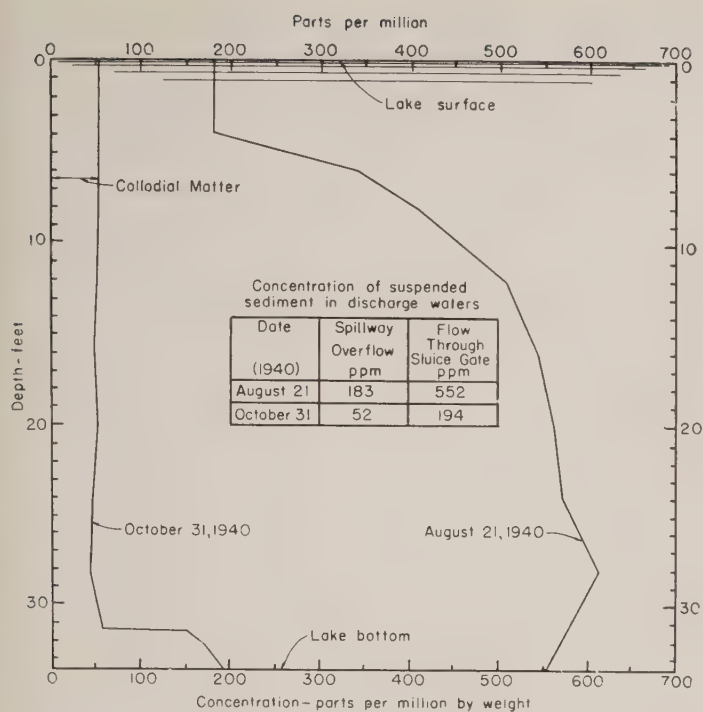
and temperature, or any combination of these factors.

Underflows of sediment-charged water coming from flood flows carrying as much as 15 percent of solid matter, have moved at the rate of over 2 feet per second in Elephant Butte Reservoir. Muddy underflows in this reservoir have repeatedly extended to the dam and have caused muddy discharges through the outlet gates while the surface water of the lake was quite clear. One of the photographs with this article shows a laboratory demonstration of the phenomenon of underflow in a reservoir and indicates the absence of any appreciable mixing of the underflow with the overlying water.

During a flood the lake water in many reservoirs, where conditions favoring underflow are not present, becomes thoroughly mixed with the inflowing sediment-laden stream water and is turbid in appearance throughout the length and depth of the reservoir; later the sediment slowly settles. Eventually all material (except colloids) reaches the bottom and the water becomes relatively clear, if conditions are not altered by subsequent floods.

A typical example of the conditions existing in a small reservoir following a flood is shown on the accompanying chart by the vertical distributions of sediment concentration observed on two different dates in Lake Issaqueena, near Clemson, S. C. This is a recreational lake approximately 2 miles long in which a normal inflow of approximately 20 cubic feet per second maintains the lake level at the spillway crest. In August 1940 exceptionally heavy rains followed in the path of a hurricane which swept the South Atlantic States. A near-record storm occurred on August 13, 14, and 15 during which period a maximum discharge of approximately 1,580 cubic feet per second passed over the spillway of the Lake Issaqueena Dam. The chart shows the vertical distribution of sediment concentration on August 21, 1940, a few days after the flood, and also on October 31, 1940, more than a month later. This latter curve shows that the only water of high sediment concentration remaining in the reservoir is a relatively thin layer approximately 2 feet thick along the bottom.

During the period between observations, sluice gates located near the base of the dam were adjusted to discharge the normal reservoir outflow so that little or no water passed over the spillway. Sediment distributed throughout the body of the reservoir by general mixing during the flood was considerably reduced in quantity during the period of sampling by both settlement of the silt and discharge of water containing high sediment concentrations from the sluice gates.



Vertical distribution of suspended sediment in Lake Issaquena.

Simultaneously with the observations shown on the chart, samples were taken of the water being discharged through the sluice gates and of water passing over the spillway. The results of these observations, also shown on the chart, demonstrate the desirability of wasting water of high sediment content, as existed in the lower part of the storage space, through the sluice gates, rather than the relatively clear surface water over the spillway. This practice has the twofold advantage of reducing the silting rate in the reservoir by withdrawing sediment before it can deposit, as well as

permitting the relatively clear surface waters to remain in storage and thus improve the recreational value of the lake. The findings shown on the chart also indicate that the effect of wasting water through the sluice gates is to create an underflow current within the underlying layer of sediment-laden water. Such a current is, of course, much more feeble than when the inflowing stream passes the length of the reservoir as demonstrated in the model reservoir.

Some writers have implied that erosion-control practices on the drainage area above a reservoir cannot reduce the silting rate in the reservoir by an appreciable amount, because enough sediment already exists in the system of channels to fill the reservoir completely. To refute such a statement it is only necessary to note that the wash load, which constitutes much the largest part of the total sediment load in most streams, does not have its main source in stream channel beds but instead comes from areas where the supply of fine material may be appreciably reduced by erosion-control practices.

In many instances, the silting rates of reservoirs may be reduced by using a carefully planned and controlled method of reservoir operation in conjunction with an adequate program of erosion control on the land of the drainage basin. Erosion-control practices may be evaluated with respect to reservoir-silting control in terms of their ability to reduce effectively the total amount of the load of fine material in the streams feeding the reservoir. A relatively small load of fine material indicates that both upstream and downstream resources are being conserved.

WORKING TOGETHER IN MICHIGAN

A MEETING of State, local, and Federal agencies called in December 1939 by Carl H. Hemstreet, county agent of Grand Traverse County, Mich., has evolved into a regular monthly dinner-discussion group.

Free discussion at monthly round tables, of the policies, services, and aims of each agency and organization, has led to a closer coordination of activities and responsibilities. Participants are representatives of the following named groups: Soil Conservation Service, Agricultural Extension Service, Agricultural Adjustment Administration, Smith Hughes Vocational Education, Federal Farm Loan Association, Northwest Michigan Farm Bureau, Production Credit Association, Grange, Farm Security Administration, Junior Farm Bureau, County Superintendent of Schools, Rural Electrification Administration, Farm Bureau Co-op.

The group has gone one step farther in cooperating

toward a more comprehensive and unified farm program. To obtain a better understanding as to how the various organizations fit into the farm picture, an individual farm was selected in which several of the agencies were deeply interested. A soil-survey map, showing soil type, slope, degree of erosion, and a land-use map with economic history and factual data were obtained, and with the aid of this information the entire group worked out a complete farm plan. The plan when finished included a conservation survey map, a new land-use map, special erosion-control practices, a cropping plan, crop and livestock feed requirements, pasture and woodlot improvements, and lime, fertilizer, and seeding requirements.

An important result of this cooperative effort was that each individual became familiar with the work of all agencies.

GOLD AND GREEN ON THE PALOUSE HILLS

BY FRANK B. HARPER¹

IT WAS about the same time Russell Lord was perfecting the continuity of his ingenious erosion "motion picture" for his TOPSOIL bulletin that the Moscow, Idaho, Soil Conservation Service staff tackled the probably less Martianesque but nonetheless sizeable task of taking some of their big black Palouse hills apart and seeing what made them tick in the erosion solar system.

The undertaking came about when Area Conservationist Leo L. Anderson finally wearied of assuring visitors that "there is more than meets the eye in these hills." He meant of course that the farmers in this, one of the richest wheat-growing areas of the world, not only had real soil erosion to contend with, but also were doing something about it.

The Moscow conservationists already knew from field observations substantiated by cooperators' figures on the South Palouse demonstration project (the first in the Pacific Northwest) that these farmers made as much money—sometimes more—when they had only 80 percent of their land in wheat and fallow or peas and the rest in grass and legume rotations as they formerly made with all of it under the old cash-crop system. Stated differently, 75 percent of the land produced 85 percent of the wheat at only 65 percent of the total family cost. But how had it happened? Many people wanted to know.

To get the answer, Anderson sent agronomists and soils men to more than a hundred of the big dune-like hills. Geologists still are arguing about the formation of these hills; but in the meantime wheat farmers of Idaho, Washington and Oregon have been making tidy livings, and fortunes too, off the land, ever since they first started plowing under the native prairie bunchgrass 60 years ago. In particular, the farmers wanted to know why it is that today, only half a century or so later, they no longer can grow as many bushels of grain on most of this still rich land.

The assignment to cover these rolling hills, with their steep north slopes and sharp tops and ridges, turned out to be anything but just another "snipe hunt" for the shovel- and sickle-equipped technicians. They brought back in their sacks indisputable proof of both the evil and the good that man has been doing to the age-old Palouse. And, today, bold charts for "him who runs to read" adorn the walls of the Moscow offices and form a focus of unfailing interest in fair

exhibits, where they shout their own answers to questions about Palouse erosion, its effects on crop yields, and the results of control practices.

It is a long way, up one of these typical Palouse hills with slopes running as high as 60 percent, and down again to the drainageway on the other side, particularly for one who is loaded down with spade and profile cases for taking out 4-foot soil columns every few hundred yards or with harvesting equipment for cutting rod-row samples the length of a mile or 2-mile distance. Actually, because of irregular field and crop boundaries, Agronomist Verle Kaiser ended up with complete yield samples on only 33 of the hundred-odd hills around Moscow in Idaho and Pullman in Washington, and Conservation Surveyor W. W. Hill with profiles—eight to the hill—on fewer than that. But they were enough to tell a real story that may affect the price of a loaf of bread in 1990.

First, for the sake of a realistic picture, take one of the actual hills that was studied—a 320-acre hill that makes an ideal ski run for the young folks of the neighborhood in winter, but from which is harvested in summer perhaps 35, or 50 or more bushels of wheat to the acre. There is no "average" Palouse hill, that is, one that could be used as a pattern to fit exactly many, if any, of the other hills. This particular hill is typical, however, in that it has the characteristic long, moderate south slope, the sharp knife-like top, and the steep north slope.

Although naturally there are no abrupt breaks between the different parts of the slope, the hill was divided into eight comparatively distinct segments, starting at the foot of the south slope where the climbing was easier and the prevailing southwest wind was from behind: The bottom 12 percent was designated as the *lower south* slope; the next 24 percent, the *middle south* slope; and the next 18 percent, the *upper south* slope. The *hilltop* took in 5 percent of the observation course over the hill. Descending the other side, one traveled successively the *upper north* slope accounting for about 1 percent, the *middle north* slope of 9 percent, the *lower north* slope occupying 30 percent, and finally the drainageway amounting to another 1 percent. Thus 56½ percent of the hill had a south exposure, and 43½ percent sloped to the north.

These percentage designations, though quasi-hypothetical, conformed closely to the previously estab-

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lished land-use capability classes for such a Palouse silt loam hill. That is, 52 percent falls in class II, 32 percent in class III, and 16 percent in class IV. On this hill, the lower south and north slopes, with their gentler gradients and better topsoil layer, were class II, and may be farmed with only simple conservation measures. These slope segments therefore accounted for 42 percent of this capability class, while the other 10 percent was found along the bottom of the middle south slope. The remainder, or 14 percent, of the middle south slope and the upper south slope of 18 percent were in class III, needing intensive conservation practices. All of the hilltop, the upper north slope by accident of location only, the middle north slope and the drainageway were definitely class IV, to a total of 16 percent of the hill field area, and could not be farmed safely without use of special controls or should not be cultivated at all.

A glance at the display chart for this field which, like the others sampled in the 1935 to 1940 study was farmed under the onetime conventional wheat-fallow system,² reveals the following interesting facts about yields per acre and soil profiles:

Hill area	Slope gradient	Yield per acre	Topsoil remaining
	Percent	Bushels	Inches
Lower south slope.....	5 to 15	51.4	44
Middle south slope.....	12 to 20	36.1	18
Upper south slope.....	18 to 25	19.9	10
Hilltop.....	0 to 5	14.0	None
Upper north slope.....	12 to 25	28.0	20
Middle north slope.....	35 to 50	19.6	24
Lower north slope.....	5 to 16	45.5	42
Drainageway.....	0	4.9	.....

In other words, the lower slopes of good class II soil, with some 40 inches of topsoil remaining, produced approximately 50 bushels of wheat to the acre, whereas the hilltop from which all the topsoil had been washed away grew only 14 bushels an acre—when 23 bushels of 70-cent wheat is the least for which a Palouse farmer figures he can afford to operate his expensive, heavy combine harvester and thresher—and the white silt-filled drainageway yielded but four bushels. A corresponding relationship between the amount of topsoil left on any slope—progressively less the farther up the hill—and the grain yield was disclosed in each of the other five measurements, except on the upper north slope, which had the benefit of extra moisture from snow drifted over the crest from the southwest but without the excessive moisture from snow drifts lying on the middle north slope late in the spring.

Any one of about 30 completely sampled fields told the same story, of hilltop and steep-slope erosion and

proportionately lower wheat yields. When Kaiser and Anderson averaged them, this is what they found:³

Slope	Present average depth of topsoil	Original average depth of topsoil	Average yield per acre
	Inches	Inches	Bushels
Lower south.....	24	30	50
Middle south.....	10.7	18	35.1
Upper south.....	4.7	14	22.7
Hilltop.....	0	9	15.3
Upper north.....	13.5	18	29.1
Middle north.....	18.7	40	18.5
Lower north.....	27.4	36	42.6
Drainageway.....	* 7.3	.....	4.6

* Silt debris.

Here, then, was the factual proof of what previous field observations had shown in a general way: That most hilltops, ridges, and upper south slopes—those slopes that stand out incongruously white or yellow when bare summer-fallow begins to dry out in the spring—have lost from 75 percent to all of their original topsoil, involving approximately 16 percent of this wheat-growing land that is held for anywhere from \$60 to \$100 an acre and seldom sold. We now had proof also that the major part of the area has lost more than 25 percent of its original topsoil, at the average rate of about 9 tons an acre each year for wheatland. Under the straight cash-crop and fallow system, the once mellow and friable Palouse loams have lost much of their capacity for absorbing moisture, to say nothing of organic matter to the extent of 35 percent and 25 percent of their nitrogen, as shown by earlier experiment station studies. Putting it bluntly, approximately a fifth of this land, originally as good as man ever plowed, has been made submarginal for continued cash-crop farming.

On the Soil Conservation Service staff at Moscow, Idaho, is Agronomist Arden W. Jacklin. He is something of an authority on the growing of grass and legumes in the Palouse—the Service's best solution up to the present for managing that 20 percent, 20 acres out of 100, on which thinning soil and lowered fertility have made grain or seed pea farming a losing business. As yet there has not been time, under the usual 6-year rotation, to study the effect of soil-conserving grass and alfalfa and soil-improving sweetclover on any of the 100 test hills; but Jacklin and Kaiser found other hills on which these forage crops had been grown in erosion-control operation, and another Palouse hill cross-section chart promptly went up on the wall.

This chart showed a 68.7-bushel wheat yield on the lower south slope, 45 bushels on the middle south slope, 2 tons of alfalfa-grass hay from the hilltop and upper

² Wheat-pea cropped fields also were sampled.

³ For complete tabulation, see tables 1 and 2.

TABLE 1.—Erosion findings on 33 sampled Palouse hills

Area	Soil type	Average percent slope	Depth of topsoil			Physical condition of the plow layer	Average maximum depth moisture penetration	Erosion	
			Average present	Range present	Average original			Degree of past erosion	Type of current erosion
Lower south slope . . .	Palouse silt loam . . .	Percent 11.7	Inches 24.0	Inches 14 to 36	Inches 30.0	{Open, mellow, friable; some silt deposition.}	72	{Slight to moderate.}	{Infrequent rills. Depth, 6 to 10 inches. Width, 8 to 15 inches. Very frequent rills. Depth, 4 inches. Width, 2 to 4 inches. Infrequent large rills. Very frequent fine rills. Depth, 2 to 3 inches. Width, 2 to 3 inches. Infrequent large rills. Slight loss of soil through wind erosion. Very frequent extremely fine rills, variable in width and depth. Infrequent large rills. Mass movement of supersaturated soil in small rivulets. Moderate loss of soil through wind erosion. Frequent fine rills. Depth, 3 inches. Width, 2 to 3 inches. Deposition of wind-blown soil material. Very frequent rills. Depth, 2 to 6 inches. Width, 2 to 8 inches. Infrequent mass movement of soil. Infrequent deep rills. Depth, 6 to 10 inches. Width, 6 to 12 inches. Gully erosion.}
Middle south slope . . .	do	20.8	10.7	4 to 15	18.0	{Slightly puddled and cracked.}	60	Moderate . . .	
Upper south slope . . .	{Palouse silty clay loam.}	22.0	4.7	0 to 16	14.0	{Puddled to subsoil; very hard and cracked; definite plow pan.}	30	{Moderately severe.}	
Hilltop	{Palouse silty clay loam, shallow phase.}	0-5.0	None	None	9.0	{Puddled, hard and cracked; baked in large blocks; definite plow pan.}	15	Severe	
Upper north slope . . .	Palouse silt loam . . .	21.5	13.5	0 to 36	18.0	{Mellow and open; some tendency toward plow pan.}	32	Moderate . . .	
Middle north slope . . .	do	41.7	18.7	6 to 48	40.0	{Slightly puddled and cracked on surface; mellow under surface layer.}	50	Severe	
Lower north slope . . .	do	11.0	27.4	15 to 36	36.0	{Friable and mellow; slightly cracked; some silt deposition.}	72	Moderate . . .	
Drainageway	Johnson silt loam . . .	0-3.0	7.3	0 to 14		White; surface baked and cracked; considerable inundation.	Saturated.	Severe	

TABLE 2.—Yield findings on 33 sampled Palouse hills

Area	Yield of Grain			Yield of Straw			
	Average per acre	Range of yield per acre	Ratio of average yield to hilltop yield	Number of culms per plant	Average height	Average per acre	Ratio of average yield to hilltop yield
	Bushels	Bushels			Inches	Pounds	
Lower south slope	50.0	29.9 to 83.6	3.20:1	6 to 8	44.1	5,800	3.82:1
Middle south slope	35.1	22.9 to 59.9	2.27:1	4 to 6	35.3	3,700	2.43:1
Upper south slope	22.7	15.8 to 24.6	1.47:1	3 to 5	29.0	2,260	1.49:1
Hilltop	15.3	11.9 to 30.8	1:1	2 to 3	21.0	1,520	1:1
Upper north slope	29.1	14.9 to 53.7	1.89:1	4 to 5	30.7	3,680	2.43:1
Middle north slope	18.5	10.6 to 26.4	1.19:1	2 to 3	36.9	2,100	1.38:1
Lower north slope	42.6	28.1 to 61.6	2.77:1	5 to 7	40.1	5,700	3.75:1
Drainageway	4.6	4.4 to 7.0	.31:1	1 to 3	18.0	700	.46:1

and middle north slopes retired together, with 66.5 bushels of wheat from the lower north slope. This when figured out for the sample field as a whole showed a 6-year yield under the soil-conserving rotation of 12,245 bushels of wheat, 65 tons of hay, and 392 animal months of sweetclover pasture, with only 7.76 tons of soil loss to the acre. Contrasted with this was the 6-year total yield expectancy under a soil-depleting winter wheat and fallow rotation of only 11,991 bushels of wheat—and that at the cost of 34.62 tons of soil loss to the acre.

The contrasting soil losses under the two farming systems in the Palouse have been measured repeatedly and over wide areas. For example, a survey made after

the 1939-40 erosion period, covering 409,425 acres on an undetermined number of farms, showed that land under such a complete erosion-control system lost an average of only 1.3 tons of soil an acre, whereas land under the cash-crop and fallow system lost an average of 18 tons an acre, both in the single season.

From the conservationist's point of view, this soil saving of itself repays the farmer for limiting his so-called cash cropping to his 80 percent of "good" land, seeding his hilltops to grass and alfalfa, either permanently or for at least 4 years out of 6, and keeping his middle slopes in soil-improving sweetclover 2 years out of 6. The preponderance of results during 6 years of demonstration in the South Palouse Project, in coop-

eration with 60 percent of the farmers in the 150-square-mile area, have shown that even the nonresident farmer with a cash- or share-crop tenant on his land can follow a full soil conservation program and make as much or more money than he could by the old cash-crop system, even if he makes no attempt to cash in on his grass and legumes beyond plowing them under for green manure. By adding livestock to his operations, as more and more Palouse farmers are doing each year, he can make money from that other 20 percent of his land that is in soil-conserving crops, although the amount will vary according to his managerial ability.

One representative demonstration farm in the project area showed a year's net increase of \$419 after the operator shifted from his soil-depleting program to a soil-conserving livestock farming system—this after allowing for an increase of \$565 in the expense of following the new program. The gross income was boosted from \$9,754 on the 582-acre farm to \$10,933. As worked out for the average 420-acre farm, the net gain in income from utilizing the erosion control crops for supplementary livestock totals \$944. The soil-improving sweetclover alone on 360 acres, with wheat figured at 70 cents a bushel and sweetclover pasture at \$1 for an animal-month of grazing, raises the net return \$555, or from \$2,383 to \$2,938. On the other 60 acres, valuing the hay at \$10 a ton, the soil-conserving alfalfa and grass serve to increase the net return another \$389 over the old wheat-fallow rotation income.

A 6-year study covering 4 grain crops on 105 fields showed that winter wheat following sweetclover outyielded that on conventional fallow and pea land by 8.2 bushels an acre, or 27.6 percent. Sweetclover as a green manure crop produces 10 to 12 tons an acre, or provides from 3 to 5 animal-months of grazing to the

acre. However, the sweetclover has been found effective in raising succeeding grain yields only on the lower-lying slopes of better soils, and its erosion-control value likewise is fully effective only on these areas. The growing of grass and alfalfa for erosion control is needed on the hilltops, steep north slopes, and the drainages that occupy up to 20 percent of the farming area.

Alfalfa yields 1½ to 3 tons an acre in one cutting. Some farmers sell their hay, and this practice is encouraged from the soil-conservation standpoint because it makes the local hay supply available to livestock operators on surrounding upland ranges and thus helps them to cut down on the grazing use of their land. Other hay is sold to livestock feeders. Grass seed production is still another profitable and increasingly popular outlet for the products of the Palouse farmers' erosion-control cropping programs.

Five years or so ago, the Palouse color scheme in the Moscow-Pullman area was green and black in winter, gold and black in summer—wheat and bare summer-fallow. Today, the style runs to gold and green—wheat still, sweetclover on the slopes and grass and alfalfa on the hilltops. Cattle and sheep now are occupying the barns that stood more or less vacant after tractors replaced the picturesque 20-horse combine harvester teams. Soil conservation districts are pushing ahead with the big Palouse face-lifting process; and all indications are that those who may venture a few years hence to dissect a hundred Palouse hills will need to keep their shovels filed—they will have to dig through tough, soil-protecting grass and legumes along almost any line of sampling in any direction over one of these hills.

"It probably is just as well that the boys gathered their data when they did," Anderson remarked, "because the Palouse is changing fast."

STUDY OF RUN-OFF

INTERESTING studies of the effect of winter ground cover versus bared soil, as related to run-off, infiltration, and soil moisture, have been carried on during the past year at the hillculture experimental plot, comprising 27 acres, near San Juan Capistrano, Calif.

This area is representative of a belt of land bordering the Pacific Ocean, starting at San Luis Obispo and extending southward to San Diego—a distance of over 200 miles—where beans are the usual dry-farmed crop.

The trends as indicated after the first year's study, are that the practice of winter-fallow results in a loss

of from one-half to two-thirds of the effective rainfall. Run-off on almost virgin land (plowed only once or twice) on a 36-percent slope was only three-fourths as much as occurred on an 18-percent slope that had been in cultivation and subject to erosion for 20 years, and the loss on such land was only two-thirds of what it was on eroded land of one-half as much slope.

The most economical solution to this problem appears to be the management of a winter ground cover in such a manner that it will give protection against erosion, but will leave in storage enough soil moisture for growth of an economic crop in spring and summer.

CLIMATE OF THE SOUTHWEST IN RELATION TO ACCELERATED EROSION

BY C. W. THORNTHWAITTE, C. F. S. SHARPE, AND EARL F. DOSCH¹

FOR two generations, or since about 1885, destructive changes in the land surface in the Southwest have become increasingly apparent. Broad flat-floored valleys have been dissected by deep gullies and the resulting lowering of the water table has diminished the vegetation of the valley bottoms. Trampling and heavy grazing by large herds have greatly reduced the available forage. Ranges that once carried 10,000 head of cattle now can scarcely support one-quarter as many, and valleys that the first white settlers converted into prosperous farms are now deeply cut badlands unsuitable even for grazing.

If, as some workers believe, the dissection of these lands of the Southwest has been brought about by a progressive change to more arid climate it is questionable whether man can effectively stop the accelerated erosion. If, as others are convinced, misuse of the land by overgrazing and imprudent methods of agriculture has been the cause it is quite possible that the land can be improved by improving the use. The evidence underlying these divergent points of view has been examined in considerable detail in a study now in press² and the conclusion was reached that the latter view has more to recommend it.

Variability is an outstanding characteristic of climate. Nowhere is the climate of one year just like that of the next. In much of the United States, the variation from year to year, although large, does not endanger the existing land-use economy. But in the Southwest the margin of available moisture is so small that even a slight fluctuation in climate may bring drastic reductions in plant cover. Climatic fluctuations are made up of variations in the several climatic elements of which precipitation and temperature are the most important.

The climatic pattern in the Southwest, and the shifts in climatic zones from year to year, are explained by the atmospheric circulation. The diurnal and annual marches of temperature and precipitation caused by the relation of the earth to the sun are complicated by fluctuations resulting from the invasion and interaction of the various air masses that enter the Southwest. These masses are cool and moist,

cool and dry, warm and moist, or warm and dry, depending on the source region from which they come and the route followed (fig. 1). They cause the day-to-day and week-to-week changes in temperature and precipitation (fig. 2). They determine the presence or absence of rain, and the size, shape, internal structure, position, and migration pattern of the individual rainstorm. The almost infinite number of possible sequences of air masses from first one and then another direction, each varying in moisture content and other properties, and an equally large diversity of interactions between air masses, some making for rain and others tending to prevent it altogether for long periods, account for the fluctuations in precipitation and temperature experienced in the Southwest.

Year-to-year variations in precipitation and temperature result in marked shifts in the climatic pattern. An area that in most years is semiarid may be arid

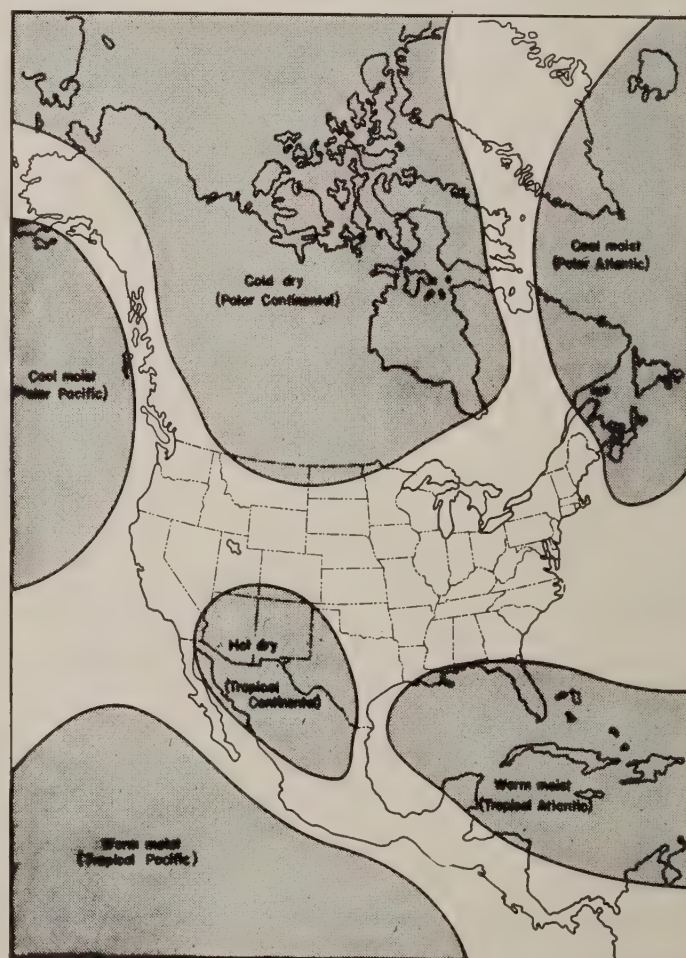


Figure 1. Air masses invading the Southwest may be cool and moist, cool and dry, warm and moist, or warm and dry, depending on the source region from which they come.

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² C. W. Thornthwaite, C. F. S. Sharpe, and E. F. Dosch: Climate and Accelerated Erosion in the Southwest with Special Reference to the Polacca Wash Drainage Basin, Arizona. U. S. Department of Agriculture Technical Bulletin. (In press.)

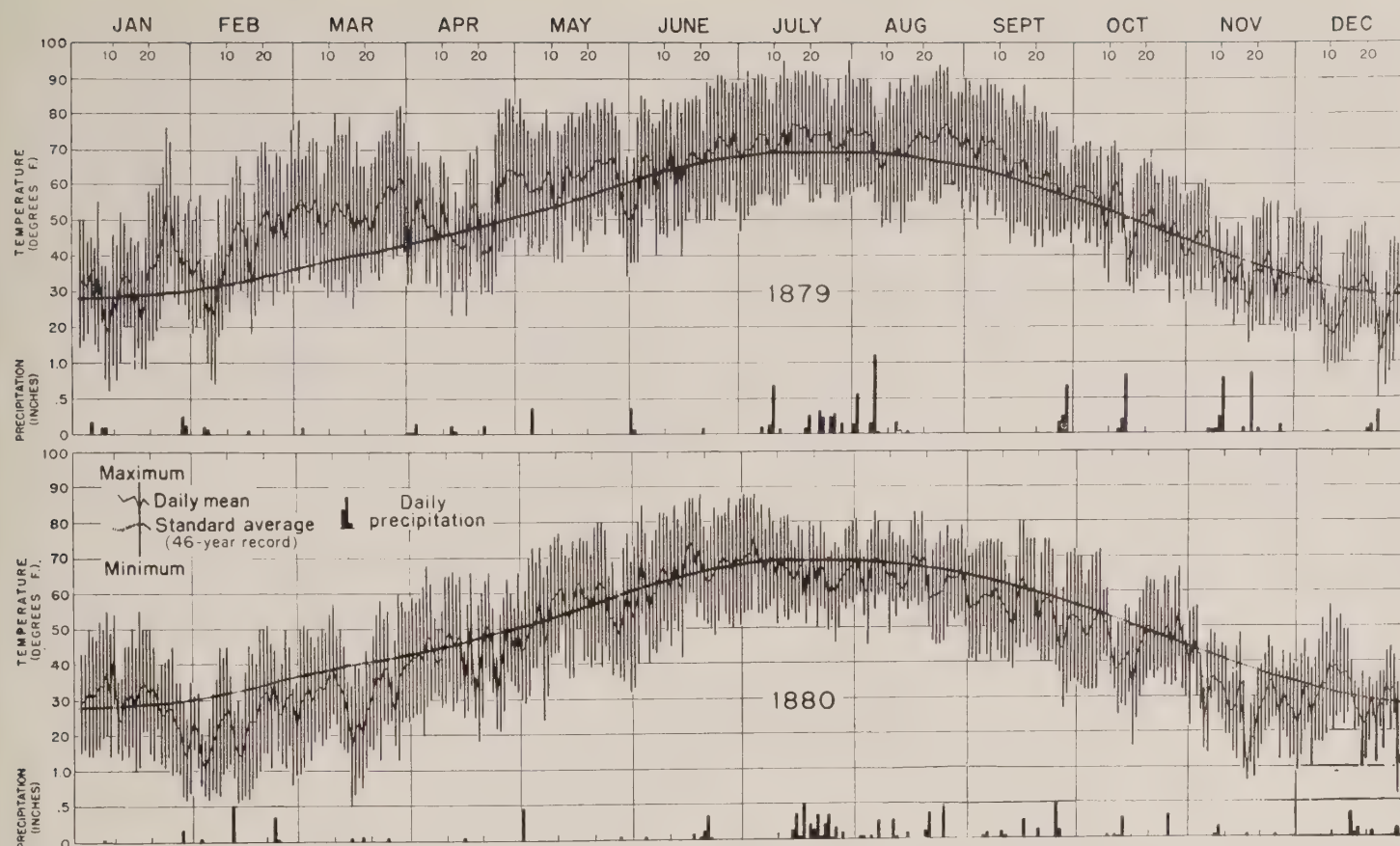


Figure 2. Successive invasions of air masses possessing different properties cause the day-to-day and week-to-week changes in temperature and precipitation shown on these charts for Santa Fe, N. Mex., for 1879 and 1880, respectively, the warmest and the coldest years at that station.

one year and subhumid or even humid the next. Fluctuations from month to month are even more striking. In a given month in one year more than the average annual precipitation may fall. The same month in the next year may be rainless.

Climatic Fluctuations Versus Climatic Changes

In the Southwest as a whole there no doubt have been wide fluctuations in climate during the past several centuries (fig. 3). Various numbers of years in succession have had far above average precipitation while dry years have followed one another as a matter of chance. These fluctuations do not constitute trends in the sense that any appreciable systematic change in climate has occurred.

The climate of the Southwest, as everywhere in the United States, has changed during geologic time; but the changes have been very slow in terms of human reckoning. Even the change since the Ice Age has been gradual, covering at least 25,000 years, and in this region it has not been very great. Climatic changes can take place only very slowly. It appears, therefore, that what often have been called climatic cycles or trends in the Southwest are in reality only short-period climatic fluctuations. The importance of this distinction lies in the fact that climatic trends or

cycles correctly identified would have forecasting value, whereas fluctuations have none whatever.

The longest continuous precipitation record in the Southwest, that of Santa Fe, N. Mex., shows that in the period, 1850-1939, there was no progressive trend from which forecasts for future years could be made. Statistical tests for persistence show that the fluctuations in the Santa Fe precipitation record were no different from what would be expected in a random series. However, a record only 90 years long cannot disprove the existence of climatic change.

In the absence of longer rainfall records many indirect lines of evidence have been examined to determine whether there has been any progressive climatic change in the Southwest during the last 2,000 years. In 1913, Henderson and Robbins (9, p. 68) summarized the evidence from archaeology, history, botany, and geology available at that time and stated that it was inconclusive; they expressed the "opinion," however, that there had been "progressive desiccation of the region since the beginning of the cliff-dwelling period."

Evidence for or against long-period climatic change must necessarily be indirect, or circumstantial, and therefore difficult to evaluate. However, the only evidence yet presented relating to the last 2,000 years is evidence of climatic fluctuations similar to those we experience today and caused by the same more or less

random interactions of air masses. If there has been any progressive climatic change in either direction it is so small as to be completely overshadowed by these fluctuations.

In recent years the science of dendrochronology, developed in the Southwest by Prof. A. E. Douglass and his students, has accumulated evidence which has been used variously to prove and disprove the existence of climatic change. A statement made only a few months ago by one of the students of tree rings shows that they are indicative of climatic fluctuations rather than climatic changes (8, pp. 67-68).

Lake levels in the Great Basin have constantly risen and fallen and have been studied for evidence of climatic fluctuations and progressive changes. According to Antevs (11, p. 71) the expansion of the Pleistocene lakes in the Great Basin corresponded to the maximum extension of glaciers in the neighboring mountain ranges and of ice sheets over the northern part of the continent. He places the last major lake expansion at 30,000 to 35,000 years ago. The well-developed shore lines and the lack of deltas indicate that diminished evaporation rather than increased precipitation and run-off was the main factor in the rise of lake levels. That large changes of lake levels in the Great Basin during the last century are associated with upward and downward fluctuations of precipitation is shown by rainfall data supplemented by tree-ring records (2).

Archaeological evidence, cited by Powell in 1898, indicates that the Pueblo cultures of the Southwest were developed under conditions approximately as adverse as they are at present (12, p. lxxii).

In recent years, Kirk Bryan and his students have presented a tremendous array of physiographic observations as evidence of climatic change. Detailed studies have been made in many valleys of the Southwest that appear to have been filled and evacuated several times in the past. Buried channels upward of one-third mile in length have been traced in the filled valleys of New Mexico (3, 4). In the Jadito, Oraibi, and other valleys in Arizona, Hack (6) has found remnants of several terraces or benches, each associated with distinctive fill material, which contain buried arroyo channels. These he interprets to be evidence of three stages of filling and three of cutting since the original carving of the valleys. Describing a series of valley fills in the Davis Mountains, Trans-Pecos, Tex., Albritton and Bryan (1, p. 1472) say:

It is a well-established working hypothesis that in an arid climate and in areas of ephemeral and intermittent streams aggradation of valley floors occurs in periods of relative humidity and erosion by channeling occurs in periods of relative aridity.

On a table giving a tentative correlation of the stages of filling and eroding in valleys of western Texas with those of the Jadito Wash, Ariz., described by Hack, each period of aggradation is indicated as "more humid" and each time of erosion, represented in the sedimentary record by disconformities, is shown as "less humid" (1, p. 1468). It is worth noting that Huntington (10, pp. 31-36) also attributes alternate filling and cutting in the valleys of the Southwest to climatic change, but he believes that aggradation is due to greater aridity and cutting to increased rain fall.

These physiographic observations and their interpretation in terms of climatic change are of much more than academic interest because they have led Bryan to attribute the recent acceleration of erosion in the Southwest to progressive desiccation. He believes that channel trenching was independent of settlement and its attendant overgrazing although the two happened to be contemporaneous. In a recent address,³ Bryan concluded that the channeling was imminent at the time when cattle were introduced into the country and the coincidence in time between the introduction of the cattle and the cutting of the channels was the same coincidence as that between the pulling of a trigger and the explosion of the cartridge. This comparison was used again in a paper published only a short time ago (5).

Processes of Erosion in the Southwest

Consideration of the processes at work in the valleys of the Southwest will show that neither buried channels nor valley terraces and fills constitute evidence of regional change from erosion by channeling to aggradation of valley floors and back again. Furthermore, the channeling and other features of the valley fill cannot be adequately explained as a result of regional changes in erosion and deposition.

Under natural conditions few of the valleys of the semiarid and arid regions contained perennial streams or even continuous channels down the drainageways. Arroyos were cut locally as a result of heavy showers and the material removed was carried only a short distance down valley and deposited as a fan. The growth of discontinuous arroyos was much like that of the discontinuous gullies formed in many of the valleys in recent years by accelerated erosion. Before the formation of a continuous medial gully down the length of a valley such as the Oraibi, Polacca, or Jadito, in northeastern Arizona, rain falling in one part of a drainage might be felt as run-off for a few miles or tens of miles down valley, but the flow

³ Great Plains Conference, Flagstaff, Ariz., September 3, 1939.

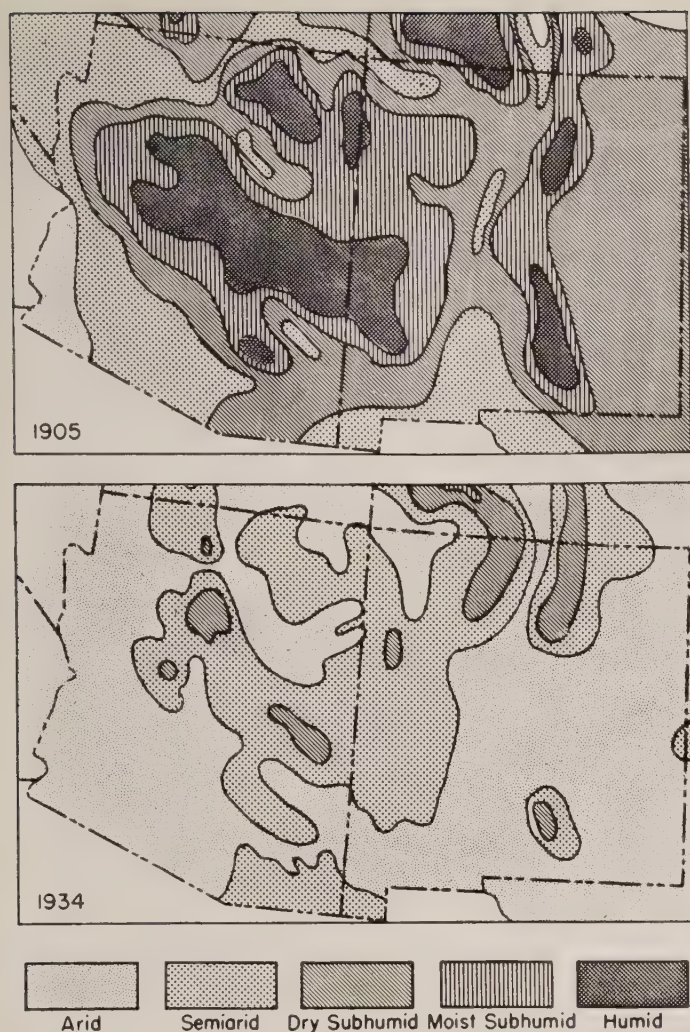


Figure 3. In 1905 an unusually large area of the Southwest had humid climate and almost none was arid. In 1934 none of the region was humid or even moist-subhumid. Arid climate was widespread.

seldom traveled much farther. Reaches of arroyo cutting alternated with reaches of deposition. In times of normal precipitation, arroyos lengthened upstream by headward erosion and at their lower ends became choked and buried by their own debris. Where a series of discontinuous channels was developed down a drainageway the head of each arroyo might cut into the alluvial fan being built by the next arroyo up valley.

Deposition at the lower ends of arroyos by back-filling of the channels (7, p. 29) produced waves of sedimentation that migrated up valley. Material removed from the head of the arroyo was transported downstream a few feet or a few miles and deposited. Although the sediment load moved down valley, the individual deposits were enlarged by addition to their up-valley ends, resulting in the upward migration of each locus of sedimentation.

During floods resulting from occasional intense precipitation the flow carried farther than usual. Channels were cleared out and fans were dissected.

Dropping of the sediment load formed a down-valley extension of the fan, or, if the lengthened channel intersected another channel down drainage, the load might be carried much farther to form a new fan. Especially in these longer channels, persistent down-valley migration of bends and meanders greatly increased channel width and in time could even cut out an entire valley fill. Excessive run-off from heavy rains, then, by cutting out of older fills caused a down-valley migration of the locus of sedimentation.

Prior to the beginning of accelerated erosion in the Polacca Wash in northern Arizona, five large discontinuous channels were cutting out fill in separate reaches of the valley and depositing it again in fan zones immediately below. With five waves of erosion and five corresponding waves of sedimentation migrating up valley simultaneously, it is obvious that at any one place erosion and aggradation would follow each other consecutively. Each fill would vary greatly in age from one part of the valley to another, depending on the time required for a sediment wave to migrate from end to end of the valley. In regions of semiarid and arid climate neither erosion nor deposition can go on exclusively throughout an entire drainage basin. Rainstorms are local and run-off diminishes rapidly beyond the limits of the storm area. Material picked up by the flowing water will soon be deposited.

The normal processes of erosion and sedimentation, some of which are outlined above, are adequate to produce successive filling and cutting of various parts of valleys without any change of climate. Complex interactions of the up-valley and down-valley waves of sedimentation offer an almost infinite variety of fill sequences. The complicated sedimentary history of many of the valleys in the Southwest is not fully revealed by the few exposures on gully walls, but even so, it is clear that the explanation of successive deposition and removal of fill lies in sedimentary processes and irregular occurrence of heavy storms rather than in any change of climate.

That a land surface which has been irritated by overgrazing and cut by stock and wagon trails will be gullied by a less intense rainstorm than will a surface in its natural condition is well recognized. It is difficult, therefore, to see any reasonable basis for Bryan's claim that overgrazing simply touched off a cycle of accelerated erosion and that gully cutting might have been initiated in the Southwest by 1940 or 1950 even had the country never been settled or used for range.⁴ Acceleration of erosion in semiarid areas where the

⁴ Great Plains Conference, Flagstaff, Ariz., September 3, 1939.

plant cover has not been depleted by overgrazing or where there has been no other form of irritation of the surface is entirely possible, and it has certainly occurred from time to time in the past. However, under natural conditions the protection against erosion afforded by the vegetation and by the soil mantle itself is sufficient for all except the most intense rainstorms. Most of the storms that contributed to the extensive gullying of the last half-century would have done little or no damage had the surface remained in its natural condition. Rainstorms of sufficient intensity to produce erosion on a surface possessing its natural protective cover are far less likely to occur than the moderately intense rains that brought about the existing gullying.

The accelerated erosion that is damaging the lands in the Southwest appears then to have been brought on by man, and by proper methods man can check the erosion and reclaim the land for his use. Mechanical

aids such as diversion dams, distribution ditches, and spreader structures, modernized since the days they were first applied by the Hopis and other agricultural Indians, can be used to keep water out of the gullies and spread it on the valley lands where it can be utilized. The major dependence, however, must be placed on a plant cover adequate to protect the soil against the occasional heavy rains. Because of climatic fluctuations this project will be more difficult in certain years than in others. Some years will have greater than average precipitation, some less. Wet year may follow wet year, or drought year may follow drought year in long series. Individual months will be exceptionally wet or dry, hot or cold. Occasional intense storms will deluge the land and, depending on the completeness of the plant cover at the time, may drain away with little erosive effect or may carve new channelways and enlarge old ones.

(Continued on p. 304)

FROM AN ARKANSAS DISTRICT REPORT

Excerpts from a semiannual report made by the supervisors of the Central Crowley Ridge Soil Conservation District, Arkansas, for the period ending June 30, 1940:

In organizing the work for the district the supervisors set up six priority areas in the district and had these priority areas mapped solid. From the interest shown in the educational meetings conducted by the supervisors, assisted by the extension service, a concerted effort was made to secure applications from every land owner in these areas so planning and execution could be done with groups rather than with so many individuals. The wisdom of this policy was shown in the first area mapped. This area was small—only 27 farms—but of the 27 mapped, 25 became co-operators, one was already cooperating with the Jonesboro SCS Camp, which left only one out of 27 not signed to cooperative agreements. This one farm is owned by an absentee landlord. In other areas the solidarity of planning has been almost as successful. 201 district agreements have been signed, all in the six priority areas. The supervisors believe this policy reduces transportation, saves time of the planning technicians, makes possible more and better execution, but above all,

it is felt that a more effective conservation program is possible through group action.

Craighead County has been designated as one of the counties in Arkansas for county-wide planning by farmer committees assisted by representatives from various bureaus of the Department of Agriculture. This work has been proceeding for some time. The preliminary report has been prepared. It is worthy of note that the recommendations made by the county planning committee for the part of county embraced in the district coincides with the program and work plan of the district. It is felt that the work of the county planning committee will further the district program for conservation very materially.

Arkansas State College, which is located within the district, is cooperating in a conservation program on the college farm. In addition to this, more emphasis is being placed upon agriculture and conservation in the curricula. Courses in conservation are being given and the college students taking these courses have made use of farms under treatment for laboratory and field studies. Members of the district personnel, upon request from the college authorities, have appeared as guest instructors before the classes studying conservation.



BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neill Faris

FOOD PRODUCTION IN WESTERN EUROPE, AN ECONOMIC SURVEY OF AGRICULTURE IN SIX COUNTRIES.

By P. Lamartine Yates. New York, London, Toronto. 1940.

This is the "Report of an Inquiry Organized by Viscount Astor and B. Seeborn Rountree" in the years 1934-38. Mr. Yates, the author, was sent by them to Denmark, the Netherlands, Belgium, France, Switzerland, and Germany to study farming systems and the "marketing boards, quota systems and other measures of control which have grown up in recent years." There is a Foreword by Sir William Beveridge in which he emphasizes the reasons for giving a high place to the study of agriculture in schools of economics.

In view of the fact that war has intervened in the 2 years since the surveys and studies were made by Mr. Yates, it is doubtful that his leading question can be answered except theoretically for a long time. The question these Englishmen wanted answered is as follows: "How far has the agricultural development in these countries been beneficial to the public welfare as a whole? in particular, has it or has it not been advantageous to them to retain in farming a much larger proportion of their population than Britain?" The book here reviewed, describing the agricultural systems of the six countries, attempts to answer that question, war or no war, and to point without faltering to the end of hit-or-miss use of the land of Britain at least, with a remolded agriculture "to serve the public interest in a more consciously planned future."

The 600-page volume will be extremely interesting to American readers for several reasons: We in the United States have long studied the economics of agriculture; we are particularly concerned with increase or decrease in production in other countries, with future policies abroad; and we are in the midst of a vigorous planning program at this time.

Historically, the development of agricultural systems in Western Europe, with its peasant farmers, is so alien to the American way of thinking that it presents a most intricate puzzle-picture that must be put together piece by piece if we are to understand past and future trends. This book is exceptionally well organized, with countries treated separately but under almost identical chapter and subchapter headings. Under "Crops and Stock" are found descriptions of the natural features of each respective country, its land utilization policy, and its crop and livestock produce. "Farms and Farmers" is the title used above the detailed descriptions of each of the six countries with regard to farm size or holdings, the agriculture population, inheritance and "parcellement," land tenure, capital or land values, farmer income, housing, education, farmer organization and cooperation. A third chapter deals with the part of the state in the agricultural system of each country.

In view of what has come to pass within the past year in the six Western European countries, Mr. Yates' beautifully written book is intensely interesting, especially those parts dealing with government control. Reading through to the end, one is inclined to believe that in spite of tremendous and soul-destroying efficiency in some parts of Western Europe, little of true value has been accomplished in the way of agricultural planning for long-time security.

The war, no doubt, has answered the question that prompted the study undertaken by a small group of Englishmen 3 or 4 years ago. At any rate, it is fortunate for all of us that they decided to publish "Food Production In Western Europe" in spite of sudden calamity, because, as Sir William Beveridge states in the Foreword, "it is a contribution of common knowledge to the solution of a common problem."

AMERICAN FARMERS IN THE WORLD CRISIS. By Carl T. Schmidt. Oxford University Press, New York, 1941.

All agree that the present "agricultural dilemma," no matter what caused it, must be solved. In this, our country, the farmer group, of all groups, cannot be allowed to "sink." The farmer's job is production of food, feed, and textile materials; he must have income. The more he produces, whether he sells it or not, the bigger the dilemma! At this point one feels like crying "Help!" and passing on to less intricate and disturbing problems. Feels like it but doesn't, for the simple reason that one has the inborn conviction that in the farm family lies the future of the nation. The author of this book believes in the farm family, in the family farm, and in farmer ownership—the reader suspects that is why he wrote this book which might be called a frank, not to say pointed, appraisal of the objectives and attainments, and/or failures of agricultural adjustment over the past decade in the United States.

The book is much too long to be reviewed in detail; but a careful reading plus notes, and a little "time out" for thinking, serves to clarify the picture as the author sees it—of the causes of present-day rural distress, of the original objectives of the adjustment program, and of just what thus far has happened as a result of that program. Questions the author attempts to answer by logical weighing and measuring are these: How much have the adjustment programs helped agricultural income? How have gains been distributed—among landlords, corporation growers, tenants, laborers, family farms? At what cost to farmers have gains been made—who paid for them, farmers or non-farm people? What has been the financial cost to the Government in subsidies and administration? What do the programs mean for the future?

A very long analysis-discussion of the farm-payment plan brings out some little-known facts and some new ideas as to real values. Under a heading, "Distribution of Benefits," the payment benefit is discussed as to effects on large commercial farming, the family farm, tenants and laborers. The hired man is called the "forgotten man" of American agriculture with almost no chance to climb, even one rung, toward the top of the agricultural "ladder." According to Professor Schmidt, he has had the worst of it. Striking also is the contrast of benefits, as shown by this book, to the farm family upon which the nation is largely dependent for preservation of democracy and benefits to the farming corporation. The author feels that share-tenants, croppers, laborers have benefited little; many have lost employment and homes, such as they were, through payments to larger farmers and landowners who were thus enabled to buy means for mechanized farming. One point, significantly brought out by the author, is that of present means and laws in certain areas, permitting the landlord to grab the tenant's share of benefit payments.



BOOK REVIEWS AND ABSTRACTS

continued

Professor Schmidt is not chary with praise of long-range farm credit; of farm security methods as the cure for the very poor and family farm ills; of actual soil conservation work on the land; of the planning work of the Department of Agriculture with its economic research and cooperation with farmers and farm communities in the effort to get away from interest-group planning to broad social planning; of government administration of agriculture in the past decade.

The first part of the book is given over to what might be called a "comedy of agricultural errors" over the past century in the United States. It includes discussions of causes—causes of what is called the "present agricultural dilemma:" mortgaged farms; tenancy and lease terms; wide diversity of farm conditions; market systems and the world's and the nation's economic changes and depressions. Summed up, the "dilemma" is, according to Professor Schmidt, the result of (1) farms being tuned in the past to supply both domestic and foreign demand; (2) decline of foreign demands; (3) mechanization, too suddenly, on the farm; (4) farmers being confronted by big business in selling their produce as well as by export tariff. The author sees United States agriculture, in world crisis, war and war's aftermath, faced with collapse of foreign markets, with the facts that other countries with cheap land have underbid us and that world international trade has become not merely "cutthroat" but retaliatory. Manufactured articles have taken the place of farm produce as exports—thus Professor Schmidt sums up the crisis, and "All in all, the United States can no longer regard itself as the granary and the cattle ranch of the world, and its exports of food and fiber seem destined, except possibly in time of war, to continue to decline in importance." This statement

may be contested, vigorously, figures or no figures, by many; yet it is nonetheless thought provoking.

Here and there, some most significant statements turn up between the covers of this volume: "... demands for foreign vegetable oils, fibers, and fruits have increased." ... If urban employment does not expand, the mechanization and abundance of agriculture is likely to be retarded and this may bring about a more self-sufficient farming. "... The most important way in which farmers try to help themselves is by political action." ... The effort to save soils is a major exception to failures thus far to build up a stable agriculture ...

It might be said that the author has familiarized himself with the functions of government agencies in agricultural adjustment only to a certain extent—he has a habit of using triplet initials when referring to the whole great program for a stabilized agriculture. In the final analysis, however, he gives us some problems to be worked out in the near future. Here they are, summarized very briefly: (1) Adjust the benefits, both Federal and those from the land, to human needs—give the disadvantaged rural people a chance, the smaller, poorer farmers, the tenants, the farm wage workers—so that in the broader sense the benefits may be distributed according "to the needs of the whole people in the future." (2) Stimulate demands, foreign and domestic, without trying to reduce production. (3) Encourage the farm-family way of living.

Thus at the very end of the book, the farm family comes into its own again, as at the beginning. Professor Schmidt, who is on the staff of the Department of Economics of Columbia University, New York City, displays in this new book a most exceptional appreciation of the significance of the present trend in American agriculture.

CLIMATE OF SOUTHWEST

(Continued from p. 302)

In spite of the large fluctuations that are characteristic of the climate of the Southwest and that at present cannot be forecast, intelligent action to reduce the irritation, increase the protection to the surface, and reduce surface run-off and loss of water will go far toward the control of accelerated erosion and the rehabilitation of the region.

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Compiled by **ETTA G. ROGERS**, Publications Unit



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¹ From Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.



ormerly worshipped in the Old World, marking many historic sites in the New, and of immense commercial value for their products, the oaks rank as the most important and widely distributed group of hardwood trees in the northern hemisphere. All told, 186 different kinds of wild birds and mammals feed upon oak products, making oaks the most popular source of wildlife food among all woody plants. The acorns are a favorite food of dozens of species of wildlife, the leaves are an important browse of deer, the inner bark is eaten by sapsuckers, the outer bark by porcupines, the twigs by beavers, the staminate aments by prairie chicken, and even the galls are eaten by several kinds of birds.

In the last 5 years the Service has planted more than 11 million oak seedlings on land unsafe to farm, in addition to "spot planting" hundreds of tons of acorns. — William R. Van Dersal.



JUNE 1941

"We must go into a new type of agriculture." Dr. Bennett discusses a way of plowing which leaves the stubble and other crop residues on top of the ground.

"The soil is truly our first line of National defense," say Supervisors of the Tri-River Soil Conservation District.

Other significant articles by H. Andrew Ireland, A. L. Harrell, C. D. Black, John G. Sutton.



SOIL CONSERVATION

OFFICIAL ORGAN OF THE SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE WASHINGTON

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Drawn by Bernard L. Simmons

WELLINGTON BRINK
EDITOR

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A GEOLOGIST PRACTICES SOIL CONSERVATION

By H. ANDREW IRELAND¹

DURING a recent trip to Oklahoma, I had occasion to spend a few days traveling with a fellow geologist who told me the story of his "back to the farm" movement during the hard times of the early 1930's.

Malcolm Oakes is a great big husky fellow, honest, kind, and a friend worth having. He was raised in Oklahoma, and to me, has all of the qualities of the pioneers who opened up the West. He has a head full of stories and knows Oklahoma intimately. I was astonished by his familiarity and personal knowledge of places, people, and geologic details. Going along he would remark, "Now, over there in that hollow," or "Just behind that tree beyond yonder barn," or "On that hill across the river," and then proceed to tell something interesting. He was good with fish stories, too.

Malcolm is a competent geologist, and until the depression he had a good position with an oil company. But, like many other good men, he was laid off and lived on his savings for some time.

One night an examination of his financial condition revealed enough funds to last only a few months. Between him and his wife it was decided that something had to be done before the funds were exhausted, while there was still a bit of operating capital.

Said his wife, "You were raised on a farm but I wasn't. However, I am willing to make a try at farming if you think we could manage it."

"At least," said Malcolm, "we could raise enough to live on and it would provide a means of getting Dad away from the city. You know Dad is over 80 and the country might do him good. The girls could go to school by bus."

A farm of 160 acres in northern Oklahoma County, a team of horses, some second-hand machinery—these were purchased for a small sum. Now, if you know that part of Oklahoma, you know that the country east of Edmond is about the reddest, sandiest, hilliest, and most eroded and gullied land in Oklahoma. Dense blackjack oak covers the upland and cockleburs, sand burs, and willows grow along the streams. What Malcolm

Oakes and his wife did to that farm was the wonder of the local residents and others. The success they achieved is worth knowing, and here lies the point of this story.

The early history of Malcolm Oakes is important in the rejuvenation of this worn-out farm. When Malcolm was a boy he lived on a sand hill farm 3 miles southeast of Ashland, Okla., in southwestern Pittsburg County. His father, John Thomas Oakes, was a progressive man and one of those rare early pioneers in soil conservation like the father of Angus McDonald. (See "The Soil Builder," *SOIL CONSERVATION*, September 1936; also "My Father Was a Soil Builder," *Harper's Magazine*, December 1940). The agricultural bible of the Oakes was an English book owned by Malcolm's grandfather called "Blakely's Industrial Encyclopedia."

In 1899 John Thomas Oakes decided to terrace his farm, a small one of 17 acres. Malcolm was given the task of making a striding level from the descriptions in Blakely's Encyclopedia. The terraces were run with a slope of 2 inches per hundred feet with a home-made hand level consisting of planks and a carpenter's level. Water was conserved, soil was conserved, and the corn production increased. The first year 20 bushels of corn per acre were harvested but within 4 years the yield had risen to 60 bushels. Cowpeas and peanuts were used between the corn rows and for winter cover. Malcolm said they had 51 acres of crops because they grew 17 acres of corn, 17 acres of cowpeas, and 17 acres of peanuts. An additional asset to good production was the location of the farm on the dip slope of the Savanna sandstone which contains phosphate nodules. The phosphate had been leached and carried away, until the terraces were built to retain the water with its phosphate and other plant nutrients.

As he prospered, John Thomas Oakes acquired more land and constructed dams for ponds and water conservation. His dams rarely washed out. His success was due to limiting the dam so that the drainage basin was not more than five times the area of the pond. The water level was traced with the previously mentioned modified carpenter's level. The dams were always located on a bit

¹ Associate conservationist in geomorphology, climatic and physiographic division, Soil Conservation Service, Washington, D. C.

of open prairie because the natural grassland indicated shale bedrock, and shale held water. Such reasoning was typical of this pioneer conservationist.

Later the farm rights were sold to a man from Iowa. All land in this area belonged to the Choctaw Nation but farming rights were bought and sold until the time when the land was divided and each member of the Choctaw tribe was given full title.

The Iowa farmer was proud of his agricultural ability, his knowledge of farming and the fine machinery he brought with him, yet from the date he took over this farm it began to deteriorate. Wonderful, straight, and accurately placed double check rows of corn were planted and the terraces were over-run by tractor, plow, and cultivator. Also the rains came and washed the soil down the check rows and removed the phosphatic nodules. Twenty years later the farm was ruined and today it resembles a rock pile more than anything else. Bedrock outcrops nearly everywhere, and only a few bales of cotton from poor scraggly stalks can be grown on what was once 17 acres of the finest land in Pittsburg County.

Malcolm Oakes went to the University of Oklahoma and became a geologist, interested in rock and oil rather than soil and farming. But in lean days he recalled his father's training and turned again to the soil. To his early farm training he had added a knowledge of geology, chemistry, and the habit of scientific thinking. He accepted the challenge of the old worn-out farm.

The red, sandy, gullied blackjack farm which he bought cheap was worth less than he paid for it, just to look at it. What would it be worth if properly farmed? The house was fairly good, possibly worth the price of the whole farm, so he considered the land as a gift.

The big gullies on the slopes were too deep to fill, but the small ones he checked by terraces made with a plow and the team of light horses. Each time around with the plow made each terrace drain a foot wider until it was 6 feet wide, and the terrace became higher and broader. A neighbor, seeing the terraces, could not believe that they had been made with a plow and a light team. Brush in the gullies and the retention of water by the terraces reduced the gully erosion. A crop of cowpeas reduced the sheet erosion. Later,

some of the deeper gullies were filled; he used a slip scraper for this. Most farmers scooped off knobs and elevations to fill their gullies, but Malcolm Oakes scooped out the bottom of his terrace drain. He used subsoil for fill instead of the topsoil. And he scooped out holes or pockets in the terrace drains so that any washed topsoil was retained, not allowed to go down the gully.

Twenty acres of formerly fertile land along the creek were covered with 4 to 6 feet of infertile sand from gullies on farms upstream. A thick growth of young willows covered the whole bottom. A dozen rounds with the plow loosened the sand between the larger willows along the former stream channel, and the first rain washed out the loosened sand. Neighbors were puzzled at so much work for apparently nothing. But Oakes repeated the process of plowing the channel after each rain and in a few months he had a channel that hid the horses.

After the first plowing of the channel he mowed the young willow thickets, and then removed them several times until a fine stand of volunteer sweetclover developed. This, when young, made good pasture for the cows. The cows did not like the sweetclover when it was tall, tough, and mostly stems, but continued cropping by the cattle kept it from growing to an unpalatable stage.

When high water came up in the spring the overflow deposited good topsoil over the bottomland, and the coarse sand remained in the deep channel where the current was strongest.

Ingenuity about the house and farmstead gave greater comfort and relieved the financial situation. The cattle needed only one water tank, so the extra one was placed on a platform made out of blackjack poles cut from the woods. A cover was made from charred but strong lumber from a burnt barn. At first the windmill pumped water to the tank and a garden hose conveyed it to the house where a wood stopper served as a faucet. Later, discarded pipe was substituted and the wash basin, bathtub, and sink were drained to a flower bed and lilac bush. Plumbing thus entered the life of this geologist turned farmer.

Occasional geologic jobs for a few days or weeks augmented the family finances, and other improvements were started. A gas pump furnished the water supply for the house and stock and to irrigate

(Continued on p. 312)

SOIL CONSERVATION

CLAUDE R. WICKARD
Secretary of Agriculture

HUGH H. BENNETT
Chief, Soil Conservation Service

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JUNE • 1941

A GOOD LIVING ON 40 ACRES

By A. L. HARRELL¹

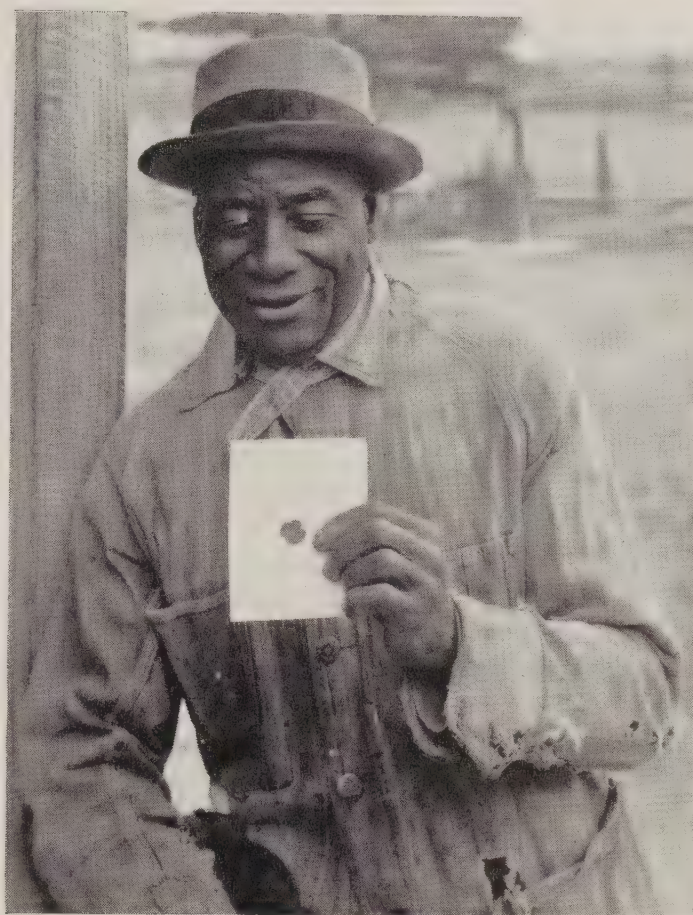
HE found a four-leaf in his crimson clover patch, but he didn't just sit down and wait for Lady Luck to change her attitude—not Bill McClellan. Bill is a Negro farmer of Calhoun County, Ala., and he does admit that having a few four-leaf clovers on his farm "didn't hurt none." There is no question about it, crimson clover has had a lot to do with helping him to make a better living for his family of six from his 40-acre farm.

Back in 1935, Bill was producing around 125 bushels of corn on 14 acres, 5½ bales of cotton on 9 acres, and 2 tons of hay from annual crops planted on 4 acres where oats failed. The only other income was from vegetables, milk, meat, and a few chickens raised for home use.

The 40 acres he had bought a few years before with money saved from a railroad job was beginning to look more and more like a bad investment. Bill was about ready to go back to railroading when Soil Conservation Service technicians of the old Anniston demonstration area helped him work out a complete conservation plan for his farm.

Corn following crimson clover began to show a big increase in yields the first year. In 1939 and 1940, he averaged 355 bushels of corn on 12 acres, 5¾ bales of cotton on 6½ acres, 7¾ tons of hay on 7 acres, 60 bushels of oats on 2 acres, 57 bushels of wheat on 2¼ acres, and approximately 2,000 pounds of unhulled crimson clover seed on 2 acres.

At prevailing prices, the total annual value of increased crop yields was \$448.13 in 1939 and 1940, with cotton and cotton seed accounting for only \$13.88 of it. The largest single item came from the increase of 230 bushels in corn yield.

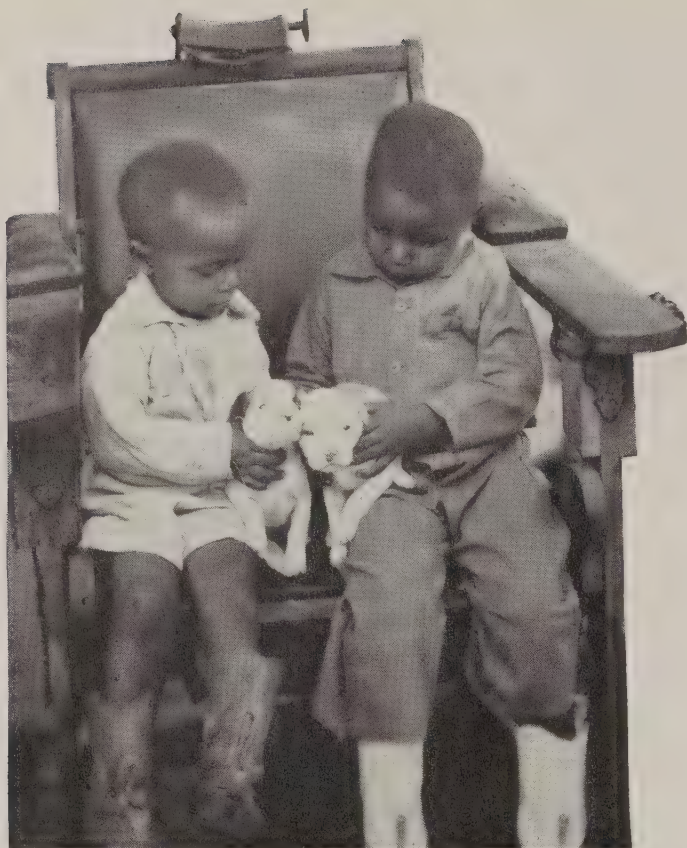


Four-leaf clovers are lucky, all right—especially if you've got plenty of crimson clover on your farm. So says smiling Bill.

Bill "made out" on 125 bushels of corn in 1935 when that was all the corn the farm produced. Then when this crop increased to 350 bushels he sold only 100 bushels and used the remainder on the farm. Although the hay crop in 1939 and 1940 was more than twice what it was in 1935, he sold only a part of the additional yield.

In other words, when corn and hay were more plentiful, the livestock kept on the farm were better

¹ District conservationist, North Central Alabama Soil Conservation District Birmingham, Ala.



Everybody's well fed and happy on Bill McClellan's farm.

fed than when he had to "make out" on a small amount of feed, and in addition he had a small surplus of feed for sale from his 40-acre farm.

Bill was not growing any winter legumes in 1935, when the conservation plan was worked out for the farm. In 1939 and 1940 he planted approximately 20 acres to crimson clover from seed produced and harvested on the farm. The crimson clover that was turned under accounted to a large extent for the striking increase in corn yield and also provided winter protection against sheet erosion on his cropland.

All the hay produced on the farm in 1935 was from annuals, but the greater portion grown in 1939 and 1940 was from 1 acre of *Lespedeza sericea* and 4.7 acres of kudzu. The kudzu was planted on land that had been abandoned because of erosion. It is estimated that after the kudzu has become well established, an annual hay yield of approximately 10 tons will be realized from the 5.7 acres of *Lespedeza sericea* and kudzu.

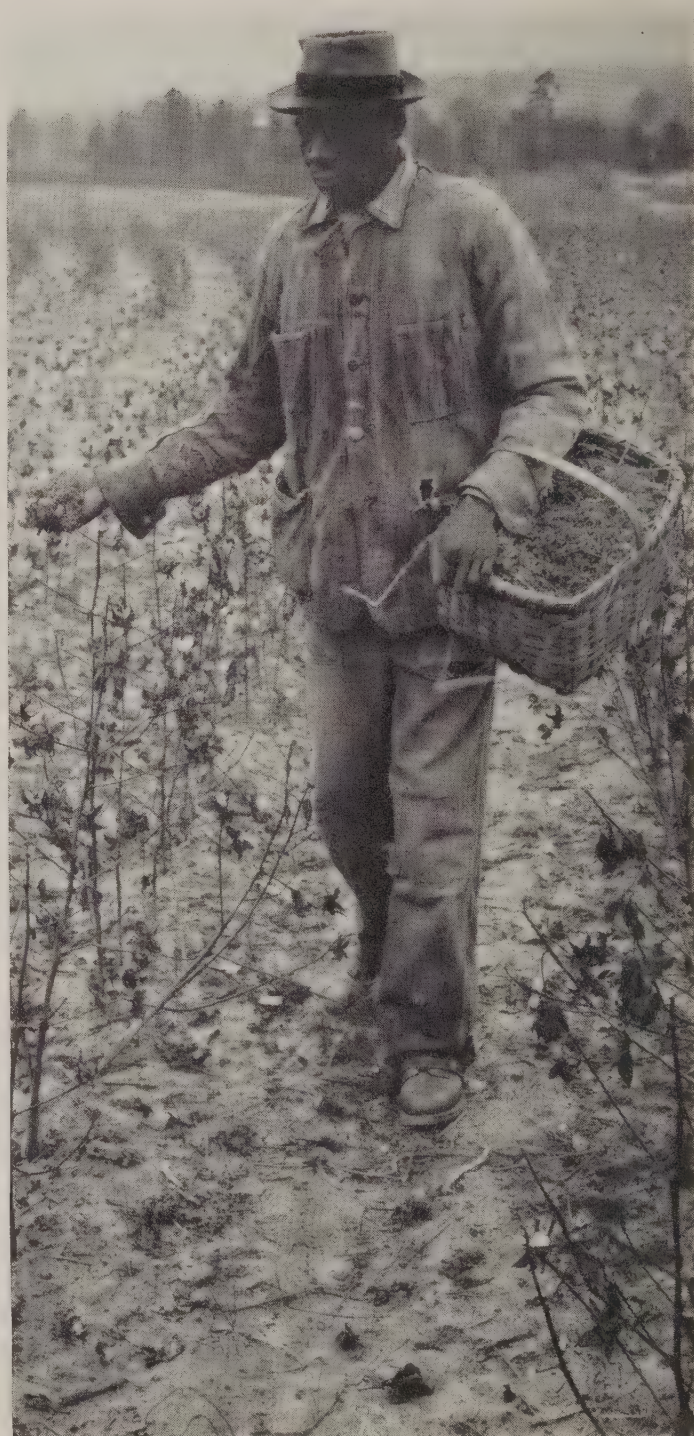
In addition to the idle land planted to kudzu, one-half acre of it was converted to woodland, and his pasture was increased by three-fourths of an acre. The pasture has been fertilized and mowed, thus increasing its carrying capacity. Improved terraces were constructed on 32 acres of cropland and a meadow outlet was established to take care of water from the terraces. A wildlife border strip was established

between the woods and cultivated land. Kudzu was planted along roadsides to protect banks from further erosion.

Annual lespedeza was seeded on all small grain and could have been mowed for hay if it had been needed. Lespedeza seed is being produced for additional plantings that will be required in the cropping system. No annual lespedeza was grown on the farm before the conservation plan was developed.

This 40-acre farm is making a comfortable living for its owner and his family, and its soil resources are

(Continued on p. 312)



Here's Bill McClellan sowing seed "with a heavy hand." You can do that, he says, when you grow the seed yourself.

83,000 PINES ARE PLANTED ON DEWEY HILL

By F. E. CHARLES and EWING JONES ¹



Hunter Hering, chairman of the board of directors, is handed a young pine tree by the Grand Haven postmaster.

Good example of community teamwork: B. P. Sherwood, bank president; Paul Hostetter, general chairman of the tree-planting bee; Ted Bolt, bank president; Leo R. Arnold, county agricultural agent.



DEWEY HILL, an 80-acre sand dune at the mouth of the Grand River on the Michigan west coast, doesn't mean much, as such, to the Nation as a whole.

But on April 19, the people of Grand Haven and the surrounding area, to whom Dewey Hill means very much indeed, staged a wholesale tree-planting bee that made this dune a symbol of the spirit that pervades each of Michigan's eight soil conservation districts—community cooperation.

Nearly a thousand men, women, and children, met on that day on that hill to plant 83,000 little pine trees to stabilize the shifting sands that cost the Government hundreds of thousands of dollars and which threaten to choke the city's harbor. The hundreds of men, women, and children—school teachers, farmers, housewives, Boy Scouts, and Girl Scouts, bankers and barbers and factory workers—showed that community cooperation could bring results.

Planting of the trees was accomplished in the face of obstacles. For 48 hours before the event, those in charge had scanned the skies and hoped for fair

weather. Even before school children began planting at 9 a. m., however, it was drizzling. At 11 a. m., thunderstorms sent them scurrying for cover. It continued to rain until 1:15, then almost stopped. Many a tired committeeman was hoping that the rain might halt for the beginning of the parade at 1:30.

As the band led hundreds of tree-planters, spades on shoulders, down Main Street, the heavens opened. The downpour came in sheets and waves. The tree planters marched down to the foot of Main Street, across a 400-foot pontoon bridge, up the steep and sandy slopes of Dewey Hill. Gales blew in from Lake Michigan, drenching men, women, and children.

Photographers' flash bulbs popped all over Dewey Hill. They showed H. H. Bennett, Chief of the Soil Conservation Service; the Reverend Mr. J. R. Euwema, Grand Haven pastor; an 85-year-old enthusiast—all making their contributions to the reforestation effort.

The trees had been furnished by the city, which also staged a barbecue. Key farmers from the West Ottawa Soil Conservation District and Soil Conservation Service personnel gave technical direction. County Agricultural Agent Leo R. Arnold was

¹ Division of Information, Ohio Valley Region, Soil Conservation Service, Darytt, Ohio.



Tree planting wasn't left entirely to the men folks. Nancy Turner, society editor of the local newspaper, here demonstrates the feminine way of planting a pine seedling.

responsible for the huge turn-out of rural people and brought about a spirit of cooperation between city and county folks. Boy Scouts guided the throngs. CCC enrollees were busy teaching the inexperienced how to plant. The U. S. Coast Guard assisted in transportation.

When the drizzly day had ended, the young red, white, and Scotch pines had joined the beach grass and picket networks to anchor the shifting sands so common to the land that once was an unending white

pine forest. There was some follow-up work to be done to complete the planting job thoroughly. Businessmen, farmers, CCC-camp enrollees, and others saw to these details before another week had elapsed. Compensating for the discomfort of the weather was the fact that the moisture proved to be fine for the trees which undoubtedly would have suffered had the day been hot and dry.

Dewey Hill is one of the largest dunes along the coast. Sporadic efforts have been made in the past to plant grass and trees, but little headway had been made. Long ago, an important portion of Grand Haven was located there. But the dune kept shifting. Eventually most of those living on the north side of Grand River were forced to abandon their homes. The old railroad station now lies buried far below the countless tons of sands that blow with the slightest wind. The coast guard dredge, *General Meade*, or the "sand-sucker" as they call it, became a familiar sight as it cleared the harbor each year. The sand kept on blowing into the river, washing down from plowed fields upstream.

Directors of the West Ottawa Soil Conservation



Water erosion on Dewey Hill—witness this alluvial fan—causes plenty of havoc.



Looking toward Dewey Hill from the city of Grand Haven. It costs U. S. Engineers approximately \$25,000 a year to dredge this harbor.

IF we of the United States are ever to succeed in conserving our natural resources for prolonged, productive use, we will need the cooperation of a great many people—farmers, city people, teachers, business men, and all the others. What the citizens of Grand Haven and Ottawa County are doing here today is an example of what I mean.

This is an event unparalleled in American history. For the first time on such a large scale, Americans from many walks of life are turning their cooperative, community energies to the business of conservation instead of the business of exploitation. Instead of burning trees, we are planting them. Instead of leveling, we are building.

In a world torn by war, the continuing will of Americans to build—instead of destroy—is a matter of monumental importance. The story of what is happening in Grand Haven today should be carried from coast to coast, and beyond our borders. It is at once a symbol of American spirit and evidence of the American will—without compulsion—to build and rebuild the strength, permanence, and productivity of this nation.—H. H. BENNETT, Chief, Soil Conservation Service, at Grand Haven, Mich., April 19, 1941.

District, first to be formed in Michigan, have a more optimistic view now. They believe that this concerted, this carefully planned and carefully supervised tree-planting bee, will put an end to the shifting sands. Dewey Hill, most of which is now owned by the city, is expected to become a forest—a symbol of community cooperation.

Reforestation is not the only means of combating erosion in the district, Hunter Hering, chairman of the board, is quick to tell you. A study of the work program, and of the cooperative agreements already signed by more than 350 farmers, bears him out.

The district has hilly areas in the dune sections along Lake Michigan. Those are sandy soils. The district has muck and rolling clay; it has plenty of good land, plenty of bad. From 50 to 70 percent of its 132,000 acres are blow soil or potential blow soil, and 60,000 acres, according to general agreement, should be in timber.

Let's examine some of the agreements. We find that, for one thing, liming is advocated, and there is plenty of marl in the district. Four marl beds have been opened, and nearly 7,000 yards sold to cooperators at cost. Liming—through cooperation.

Improved crop rotations are being used on all cultivated land. They include legumes to build up fertility of the soil, and are planned to keep the land under cover as much as possible.

Strip cropping is used even on the level land—as protection against the wind. Contour cultivation is practiced. Winter cover and green manure crops are included, pastures are being improved, sod waterways are being installed. Sixty-seven miles of windbreaks have been established. Yes, Hering is right: Reforestation is but one phase of the cooperative attack upon soil erosion in the land of shifting sands.

Cooperation continues to dominate the activities of the wildlife program, in which the district cooperates

with the North Ottawa Rod and Gun Club and the Holland Fish and Game Club. The Rod and Gun Club has helped out by furnishing a seeder and cultivators for the nursery, and in cooperation with the district has started a campaign against burning. The club also is aiding the district in obtaining a fire tower. One hundred and seventy-five thousand shrubs for wildlife food and cover were planted, and numerous feeding stations were established through the winter.

At the outset, tree planting was handicapped to some extent by lack of sufficient quantities of planting stock of desirable species. Cooperation again: The district established its own nursery with an annual output of more than 2,000,000 trees. Frank Garbrecht, one of the directors, donated the land. Moreover, a number of farmers were encouraged to grow their own tree planting stock from seed. At least 65 landowners now have small private nurseries.

The directors have tapped many sources of assistance other than the Soil Conservation Service. There are the two conservation clubs mentioned, the Civilian Conservation Corps, the Agricultural Extension Service, the Grand Haven Chamber of Commerce, State Conservation Department, county and township highway officials, public schools, county board of supervisors, the U. S. Forest Service, University of Michigan, Agricultural Experiment Station, 4-H clubs, many local organizations, and individual business concerns.

The reforestation of Dewey Hill was but a symbol—a symbol of community cooperation. But farmers of the West Ottawa Soil Conservation District are convinced that the democratic solution will work.

GOOD LIVING ON 40 ACRES

(Continued from p. 308)

being conserved through a sound land-use plan with every part of the farm utilized according to its capability. There is not a waste acre on the farm and the soil-conserving vegetation that is being grown for the protection of land against erosion is augmenting the supply of forage, improving the fertility of the soil, and increasing both acre and total yields of the various crops.

Like most good farmers, Bill is a good citizen. He is a leader among members of his own race in his community and has been directly responsible for several conservation plans that have been developed on neighboring farms first in cooperation with the Soil Conservation Service project and more recently with the soil-conservation district of which his community is a part. His farm has been visited by numerous groups of both white and colored farmers and the excellent demonstration of what can be done on a small acreage

has encouraged many of them to apply for assistance in developing conservation plans for their own land.

Bill McClellan has proved to the satisfaction of those who have visited his farm that it is possible to develop a sound farm program on a small acreage without large cash outlay. Through the wise use of his limited financial resources, he has increased the value of his property and has made his farm produce a much larger income than he was receiving before his conservation plan was established.

GEOLOGIST

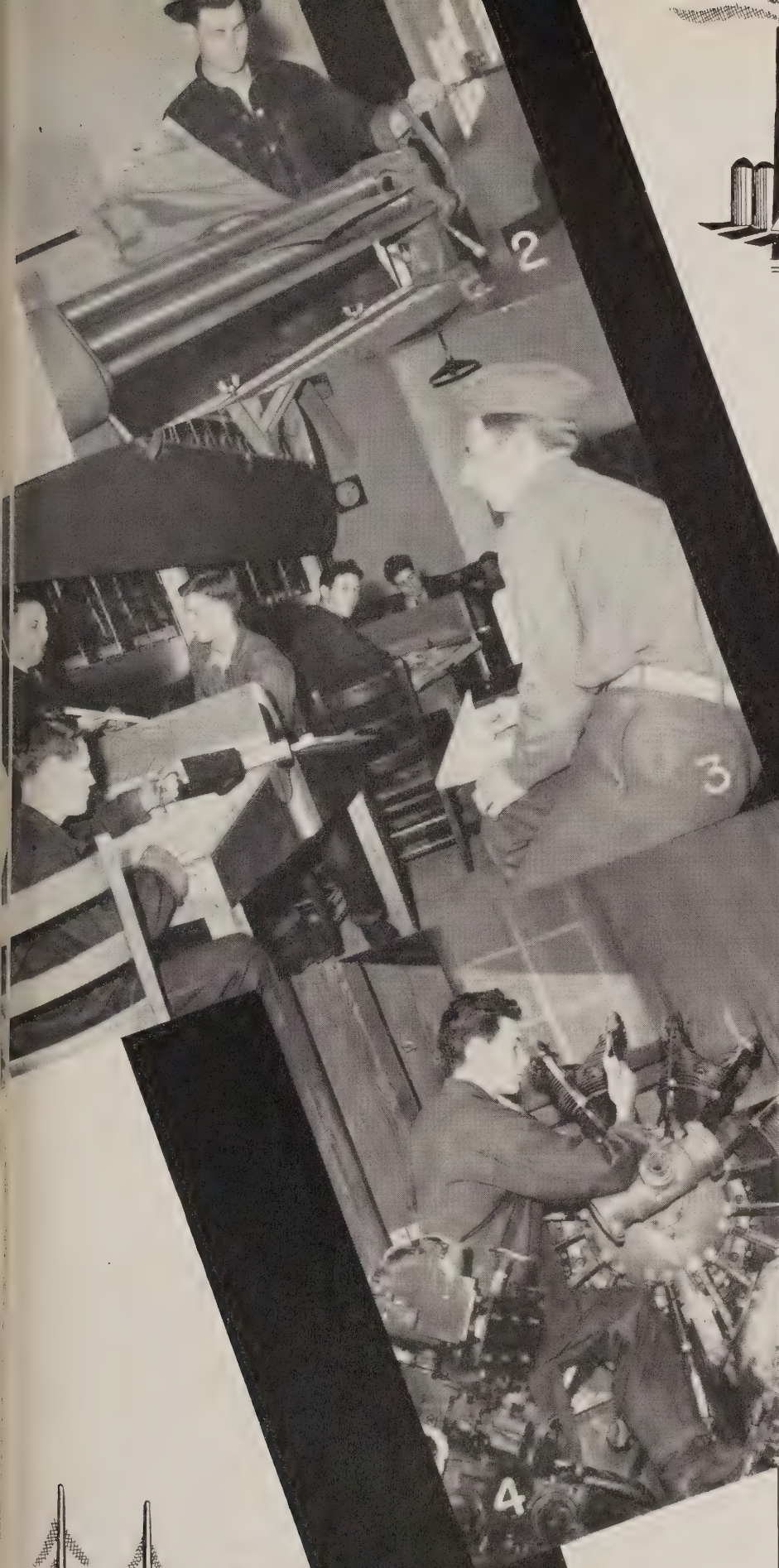
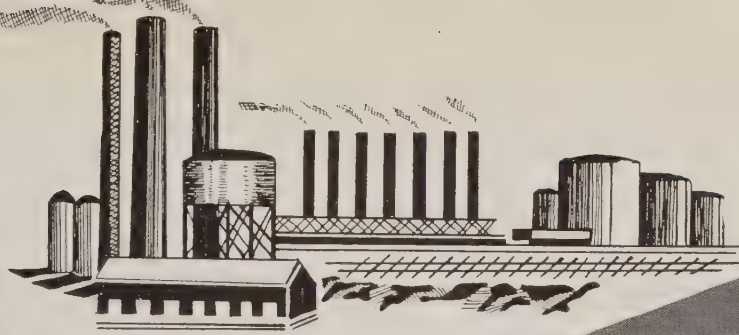
(Continued from p. 306)

a garden. A washing machine was acquired, to serve its own purpose as well as provide power for a bean huller. The bean huller was the wringer. Cloth strips were used to separate the rollers enough to allow hulls to pass but retain the beans. When the beans were mature, they were picked and not allowed to dry; they were scalded, run through the wringer, and then canned. Large fresh soft beans thus were on the shelf instead of hard starchy beans that required soaking and hours of cooking.

After about five years of farming, less several months of occasional calls for geologic work, times began to be better. In 1937 a good offer for geological work appeared. In discussing it Mrs. Oakes said, "Malcolm, I have kept a careful account of expenses and income during the last 5 years. I have accounted for everything in terms of what food, clothes, and necessities would have cost had we lived in town, and have added to that the income from produce we sold. Just now, we have an income equivalent to \$2,000 a year in town, and if you can't get an offer for more, I say stay on the farm."

An income of \$2,000 from that hilly, red, sandy, gullied, blackjack country east of Edmond! I know the country. I have been through it before roads were paved and afterward. I have hunted in it and fought fire in the blackjacks. It seems unbelievable that anyone could make a success on a farm in such an area. Conservation is worth the energy, trouble, and time, if intelligently planned, isn't it?

Another offer for geologic work was for more than \$2,000 and a year or so later the farm sold for more than Malcolm Oakes paid for it. The beans and other canned produce lasted 2 years. I wonder if the farm still produces an income equivalent to \$2,000 a year.



Devoting work hours to waging war against soil erosion, CCC enrollees in camps supervised by the Soil Conservation Service are spending leisure hours studying to become replacements in the industrial defense program. To meet the needs of industries producing defense materials, CCC camps are redoubling efforts to make training timely.

Now added to the curriculum of the SCS camp at Vista, Calif., is a course in aviation mechanics which is approved by aircraft industries. The course is taught by an instructor furnished by the Escondido High School, and requires 200 hours—three months enrollee leisure time—to complete.

Illustrations show enrollees, (1) at work during regular hours, constructing a rock masonry dam as a part of the water facilities work of the Service. Leisure hours at the Vista camp find future aviation mechanics (2) learning to roll metal used in airplane bodies, (3) studying job specifications, and (4) reassembling a Wright cyclone engine.



NEW TILLAGE METHODS CITED

BY H. H. BENNETT

(From the printed record of hearings before the Subcommittee of the Committee on Appropriations, House of Representatives, considering Department of Agriculture Appropriations for 1942)

MR. CANNON. Tell us about this provision for the Soil Conservation Service.

DR. BENNETT. Before we go into the financial details, Mr. Chairman, I wonder if I could show you a couple of plows I have here. This will show you something of the type of progress being made in our work.

Method of Controlling Crop Residue as Protective Cover to Ground

We have made decided progress in the control of erosion, with the funds given us by Congress, by using all the preventive measures we know about on the different kinds of land we have in the United States that need treatment, but we find that the best we can do generally does not provide complete control. We are now getting around 85 to 90 percent of effectiveness with respect to the control completed; now we must close the gap between 90 percent and 100 percent in effectiveness of control. To date we have used for the most part such measures as strip cropping, contour cultivation, crop rotation, gully control, and many others. But I think now we must go into a new type of agriculture in the United States. Generally, we have been plowing under the crop residues left on the land, such as wheat stubble, for example, and the residues of other crops. We have been turning everything under in preparation for the next crop, thus exposing the bare soil to the rain and wind. Now, with this new type of agriculture that we are trying to put into effect, and in which we are making some real progress, we plow the land in a different way from that employed under the old methods. By this method of plowing, we leave the stubble and other crop residues, as, for instance, wheat straw, on top of the ground.

That is accomplished by using a plow that runs beneath the surface without turning the soil over. This type of plow [exhibiting] indicates what has been done in Nebraska, where we have been carrying on research work and field experiments to find practical ways of carrying out this type of plowing. This [indicating] is the machine or the plow that is doing this type of work. This is a different type of plow from the turnplow. As you will see, it runs almost level. It is set so that the machine really pries the

soil up, loosening it, rather than being forced directly through and turning the soil over and all the vegetative cover according to the old method. This machine runs about 5 or 6 inches beneath the surface, cuts off the weeds and leaves the residue on top of the ground. This type of cultivation preserves almost three times as much of the rainfall as is ordinarily preserved by the summer fallow type of cultivation, which turns the trash or residue under. Under this method, the Nebraska experiments showed that the soil contained at the end of the season 9.7 percent of the moisture, where a mulch of wheat straw was used while with the summer fallow method only 3.7 percent of the moisture was conserved. By this method you conserve, as I have said, 9.7 percent of the moisture, while by the basin listing method you conserve only 4.9 percent of the moisture. If there is no plowing of the land, only 1.2 percent of the rainfall is conserved on bare ground. The following table shows the moisture-saving effect of this practice of surface mulching—stubble mulch we call it—together with subsurface cultivation:

Effect of straw mulch and different tillage treatments on the storage of water in the soil near Lincoln, Nebr.

Treatment	Part of 17.9 inches of rainfall conserved (Apr. 23 to Sept. 8, 1938)		Depth of water penetration
	Surface inches	Percent	
1. Straw, 2 tons on the surface, plowed beneath straw without turning up soil. . .	9.72	54.30	6
2. Straw, 2 tons plowed in, part of subsurface turned up.	6.12	34.20	5
3. Land plowed, no straw (summer fallow). . .	3.71	20.70	4
4. Basin-listed.	4.95	27.70	5
5. Bare, unplowed.	1.23	6.87	2

MR. CANNON. What is the comparative percentage of rainfall conserved?

DR. BENNETT. By this method we conserve more than twice as much of the rainfall as would be conserved by the ordinary summer fallow method, about twice as much as with basin listing, and eight times as much moisture is conserved as would be conserved on bare ground with no plowing at all. Of course, the farmers do not leave the ground bare, but eight times as much moisture is conserved by this method as would be conserved if the surface were bare and no plowing were done.

This recent photograph shows work in Georgia, on a farm near Gainesville. This farmer never plows anything under in the way of vegetative litter, but he has a plow that runs through the soil like this. This plow goes down about 12 inches on this land that was in cowpeas. He can plant corn here by running a little water furrow through the ground. This farmer has practically no erosion, although he not only has erodible soil, but he is cultivating even steeper slopes than are found on the average farm in this Piedmont section. He has used this sort of plow with a high degree of effectiveness. There is no wing on it, and it does not turn the soil over. It is set so that the topsoil and the residue on it is pried up but not turned under. We have one of those plows here.

Mr. CANNON. That is apparently the plow used before Jefferson invented the moldboard.

Dr. BENNETT. I think it is very much like it. At one stage, about Jefferson's time, they had a plow something like this with a small wheel attached in front of it—a sort of colter. This gentleman down in Georgia has a 100-acre farm, and he makes these plows himself. He makes them so that he does not turn under any considerable part of any crop residue or stubble. This is a new type of agriculture that is now gradually being developed in the United States.

Mr. CANNON. That would be of special value in the Missouri Valley, the Mississippi Valley, and Ohio Valley where the soil is practically level and there is little erosion due to washing?

Dr. BENNETT. It is still of importance; it has some additional value in that it reduces leaching somewhat, and it helps greatly to conserve the rainfall.

Mr. CANNON. You consider this a revolutionary appliance and believe it is the coming method of cultivation?

Dr. BENNETT. Yes, sir; and it is being adopted. Incidentally, one gentleman, a Mr. Chase, is now manufacturing the winged plow I showed the committee. He sold some 300 of these plows last year to farmers in Nebraska and neighboring territory, and perhaps other implement manufacturers will also make them.

Mr. CANNON. That would be true if you were planting after soybeans, which pulverize the soil and leave it loose, but how would it operate in a tight sod which has been in pasture for 2 or 3 years?

Dr. BENNETT. I think you would have some difficulty especially in clay types of soil such as we find in regions where the soil is derived from shales. There would be difficulty in the case of the Pierre

clay, a stubborn shale-derived clay soil. In such soils this machine would probably not be sufficient to produce the ideal tilth if there were a thick growth of grass on it, but under almost any ordinary condition it does leave an ideal tilth for seeding without further preparation; that is, after summer fallow.

Mr. PLUMLEY. What do you mean by "tilth?"

Dr. BENNETT. That is soil mellowness. It is a spongy condition, or a good mellow condition—spongy, so that you can dig into it with the bare hand.

Mr. PLUMLEY. Looking at that plow, it seems as if there would be a trench driven between the rows. Is that right?

Dr. BENNETT. There is a little trench—scarcely more than the furrows of a grain drill.

Mr. CANNON. Do implement manufacturers recognize the importance of that design?

Dr. BENNETT. Yes, sir.

Mr. CANNON. Are they putting these plows on the market?

Dr. BENNETT. Yes, sir.

Mr. CANNON. Have you issued any bulletins on this new type of cultivation?

Dr. BENNETT. Some papers have been published by the American Society of Agronomy, and we have prepared a bulletin about it.

Mr. CANNON. Will you give them a list of the names of the members of this committee to receive a copy of the bulletins when they are available?

Dr. BENNETT. I will be glad to do so.

Mr. CANNON. You may proceed with your statement, Doctor.

Planting of Trees, Grasses, etc., for Soil-Erosion Prevention

Dr. BENNETT. Here [indicating] is a photograph showing application of that principle of work, near Caddoa, on the Arkansas River, in southeastern Colorado, where the Army engineers are building a great dam as a flood-control and water-conservation dam. They started this project, I think, because down the Arkansas River every spring great quantities of water run to waste from the melting snows in the Rocky Mountains. Nobody gets any good from much of this water. Oftentimes it does a lot of damage on the way to the Gulf, causing troublesome floods. They have an important irrigation agriculture along the Arkansas, and almost every year, many years at any rate, there is plenty of water in the spring but not enough when summer comes. Sometimes upward of half the crops are seriously damaged or ruined because of summer or late-summer scarcity

of water. Year before last, I think, they had a serious situation like this.

In building this dam something like 20 miles of track of the Santa Fe Railroad was to be inundated. The Army engineers asked the Santa Fe officials if they would move their tracks to the adjacent uplands, just to the south. They said in effect, "We cannot move the tracks to the south because of the sand dunes prevalent in that section. The sand will be constantly blowing over the track and we will have a perpetual expense to remove it." They were willing to move the track to the north, but that would have necessitated payment by the Government for building 2 expensive bridges across the Arkansas River. There were also many other expenses that the U. S. Government would have had to bear. Well, one of the Army engineers, as I was informed, advised that they go down to the southern plains section near Dalhart, Tex., to look at some dune-control work that the Soil Conservation Service had carried on there in its research program in an attempt to control wind erosion, and where some 70 dunes had been controlled successfully, mainly by leveling the higher points and putting in adaptable vegetation. So the Santa Fe engineer went down there, investigated the dune work, and agreed to recommend that the company move its track to the south provided the same sort of work be done to control the dunes at Caddoa.

One of our men was assigned to work with the Army engineers on the Caddoa undertaking, and they controlled something over 50 dunes, running up even higher than this one in the photograph [indicating]. When I was there last fall, I saw dunes that were 20 feet high a little while before, which had been stabilized by planting grasses and putting a layer type of wheat straw over the surface of the ground. The perennial grasses, such as rye grass and blue grama-grass, were seeded. They have controlled the problem out there very effectively. When I got there, the Santa Fe Railroad already had not only agreed to move the track but they had prepared to move it. The job was about finished—cuts dug, fills made, and the roadbed about ready for laying the rails. It will all be finished this year. The difficult work is already completed.

The total maximum cost of the dune-control work is estimated to run something under \$140,000. I do not think it will run to above \$100,000. The saving to the U. S. Government on that one job will be in the neighborhood of \$3,000,000, according to my observation and reports gathered ideally. That job was accomplished by the utilization of a modification of this same method referred to under this new type of agriculture—this preserving of crop residues—stubble, straw, and so forth—as a protective cover to the ground.

COOPERATORS APPRAISE CONSERVATION PROGRAM

By C. D. BLACK ¹

WHAT do cooperators think of their farm plans after they have been in operation several years? During the past year a studied effort was made to obtain a fair appraisal from cooperators of Ohio's oldest soil conservation demonstration, the Salt Creek project, which was also one of the first established in the Nation. Part of the survey was conducted by personal interview, the remainder by mailed questionnaires that for the most part could be filled out by simple affirmative or negative answers.

To set up a representative cross section, the cooperators first were classified, or graded, in accordance with their attitudes, types of farms, quality of demonstrations, etc. Cooperators in each grade were then rated proportionately. In all, a total of 135 individuals responded, or nearly 43 percent of all

those having cooperative agreements in force when the survey was started.

The survey was divided into five parts, general soil conservation farming, strip cropping, pasture improvement, alfalfa-grass meadows, and woodlands.

Most heartening of the responses in the series of general questions came from the 68 percent saying that their neighbors' attitude toward the program had improved. Nearly 74 percent stated that the program had increased the value of their farms, and 59 percent said it had boosted their incomes. A thumping 88 percent declared that they would continue the plan after the agreement expired, and 56 percent believed no further assistance was necessary.

Strip cropping.—What the farmers think of strip cropping is shown by the following percentage summary of affirmative and negative answers to questions asked them.

¹ Project technician, Ohio Valley Region, Soil Conservation Service, Zanesville, Ohio.



Salt Creek cooperators say that strip cropping increases yields.

	Yes	No
	Percent	Percent
Does the practice satisfactorily control erosion?.....	85	15
Is the practice inconvenient?.....	39	60
Does the practice increase cropland yields?.....	75	25
Will the practice be continued?.....	90	10

Pasture management.—The improvement of permanent pasture has been considered one of the more important phases of the program in the Ohio Valley Region. The cooperators' appraisal of the program in the Salt Creek area disclosed several interesting facts about the pasture problem:

	Yes	No
	Percent	Percent
Were results from pasture treatment satisfactory?.....	85	15
Have you treated more pasture with lime and fertilizer? ..	31	69
Will you treat more?.....	85	15
Do you clip pasture?.....	49	51
Will you clip next year?.....	65	35

The work that has been done thus far along the line of pasture improvement in this area appears to have met with a fairly high degree of success, but the acreage treated represents only a relatively small proportion of the total pasture on the farms in question. The question therefore arises: What will be the status of pasture improvement in this area in the future? Almost one-third of the cooperators reporting indicate that they have treated additional pasture, and 85 percent will treat more. At first thought this would indicate that decided progress already has been made with the pasture problem and that treatment will progress rather rapidly in the future. Observations show, however, that those who have treated more pasture have done so on a small scale and some have applied only lime, or fertilizer alone.

Although half of the cooperators indicate that they clip pasture and 65 percent intend to do so in the future, the use of this practice is not noticeable in this area. It appears to be spreading, however, and is likely to be somewhat generally adopted in the not-too-distant future.

Alfalfa-grass meadows.—Cooperators' opinions of alfalfa-grass meadows are best shown by further summarizing answers to questionnaires:

	Yes	No
	Percent	Percent
Was your alfalfa-timothy or alfalfa-orchard grass meadow satisfactorily established?.....	82	18
Has the same area been renewed?.....	28	72
Have you increased the alfalfa acreage on your farm?.....	58	42
Can alfalfa be renewed without going through a corn crop?...	79	21
Was alfalfa-grass meadow the proper use for the area?.....	86	14
Should alfalfa be grown:		
(1) on a definite area?.....	61	.....
(2) in the rotation?.....	22	.....
(3) in both rotation and on a definite area?.....	17	.....

It will be seen that a large majority of the alfalfa-grass meadows were satisfactorily established. Furthermore, we have noted that many of the 19 percent classed as unsatisfactory in reality were superior to other meadows on the farms in question. This success with such a large number of meadow seedings is somewhat remarkable, considering that only a relatively small number of these farmers ever had grown alfalfa before.

Woodland management.—Of all the trees planted in the Salt Creek area, black locusts were classed by cooperators as most successful from the standpoint of both survival and growth. Pine plantings were rated as second best. The cooperators' opinions of their farm woodlands may be noted in this summary of their answers to 12 pertinent woodland management queries:

	Yes	No
	Percent	Percent
Have planted areas been grazed?.....	9	91
Will you continue to protect from grazing?.....	85	15
Will you plant more trees.....	28	72
Was tree planting the proper treatment?.....	99	1
Is pasture loss noticeable as the result of fencing established woods from pasture?.....	19	81
Has this existing woods area been grazed?.....	10	90
Will you continue to protect from grazing?.....	83	17
Will you fence off more woods?.....	5	95
Is natural reproduction abundant?.....	73	27
Do you anticipate a regular income from the woods?.....	17	83
Do you plan to harvest timber on the selection basis?.....	52	48
Is permanent woodland the proper use for the area?.....	94	6



This alfalfa stand was produced on an eroded field (like the one beyond the fence) formerly covered with poverty grass. The alfalfa is on the farm of a Salt Creek cooperator.

Visits to plantations on a hundred farms by the Muskingum CCC camp forester showed that about 30 percent of the cooperators had allowed grazing in varying degree. However, only a little over one-fourth of the cooperators appear to be interested in future additional plantings even though in general they agree that such treatment was proper for the areas in question.

Although slightly more than half of the cooperators

expect to harvest from their woodland on a selection basis, only a relatively small percentage of them expect a regular income from their woods. Although the farmers who are planning to harvest timber on this basis may not have an altogether adequate conception of selective cutting, nevertheless it is likely that they will realize more from their timber sales than will those who continue to use the slash method

TRI-RIVER SOIL CONSERVATION DISTRICT POCAHONTAS, ARK., DECEMBER 31, 1940

(Semiannual report, submitted by the Board of Supervisors)

IN July 1940, the supervisors of the Tri-River Soil Conservation District submitted a semiannual report and commended the different Government agencies and civic organizations on their splendid cooperation with us in our efforts to establish community centers and community leaders for the development of proper land use to lead to a permanent agriculture and a fuller economic farm life for the people. We feel that this has shown wonderful progress. Quoting from our Narrative Report, July 1940:

It is not for the sake of the soil alone that we attempt to keep our district alive to the fundamentals of good farm practices but for the maintenance of the farm families who take their life from this soil with their own hands. We are firm in our belief in the statement of President Franklin D. Roosevelt that "the soil is truly our first line of national defense" and our strength for the holding of this line constantly becomes greater as new cooperators join our ranks.

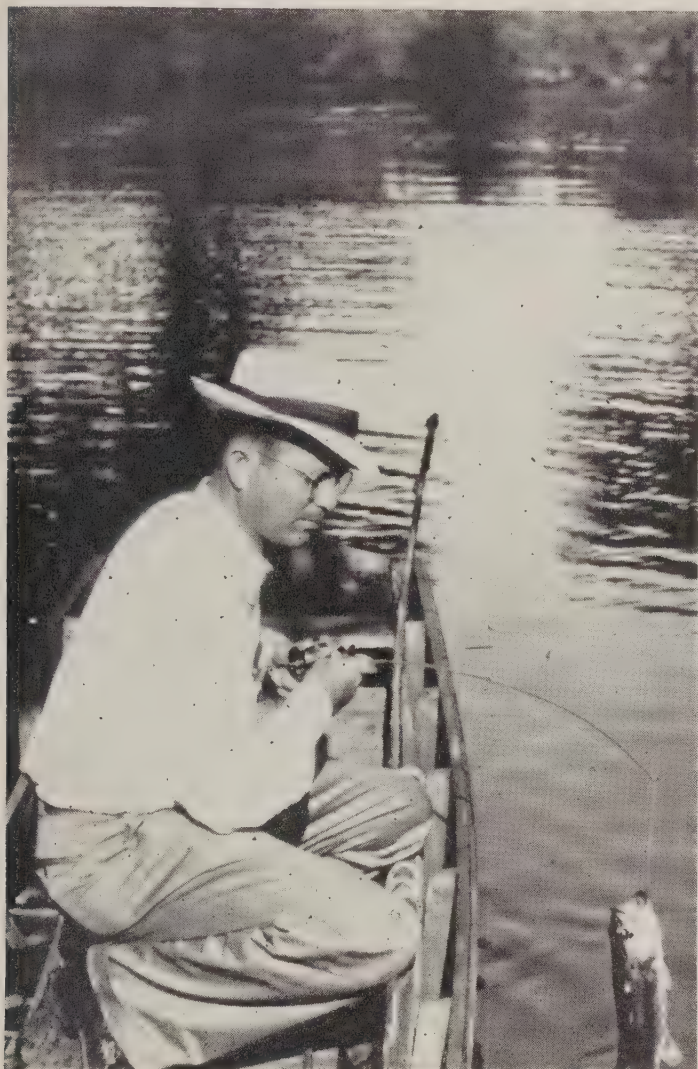
With this in mind it is our hope as farmers and supervisors, through our connection with the local leaders, to help prevent what we saw happen in the last great war; that is, the opening up to erosion, by cultivation, of land that should never have been plowed. It is our grave fear, that unless there can be a coordinated effort on the part of all agriculture workers to prevent cultivation of steep slopes, overgrazing of pastures,

unmerciful slashing of woodlands, that instead of progress in conservation we will have progress in devastation. We realize the danger of these erosion hazards with the possibility of higher prices due to the national defense program or war itself.

To date, much progress has been made in our district toward soil conservation and establishment of erosion control practices. We are sure that our national agricultural leaders foresee the hazard of increased prices and the way it might become a menace to soil conservation and permanent agriculture. We feel, however, with our present district set-up, with our local leaders and township committeemen, that we are in a position to prevent a tearing down of the progress already made in our district. Our community leaders seem to us to be in just the position to deal directly with the individual farmer in coping with any national emergency that might arise at the expense of the soil.

Since approximately 65 percent of the Tri-River Soil Conservation District is in actual woods or potential woods, it behooves the supervisors to give more consideration to the problem of proper woodland management. The national-defense program has opened our eyes to the value of our farm timber, and we should remember the devastating effect World War No. 1 had

on our timber, and at this time put more stress on the sound management practices recommended by district technicians. Because of the sharp increase in timber prices within the past 6 months, we should impress upon the district cooperators, more than ever, the importance of sustained yield, proper cutting, protection from fire and grazing, cutting damaged and diseased



Numerous streams wind through the Tri-River District. Although not so good as they once were, they still provide some excellent fishing. The supervisors look for still better fishing as soil conservation comes to the aid of such streams as the Eleven River, a glimpse of which is seen here.

trees first, removing trees in such a manner that large openings will not occur. We feel that this can be done better through our community leaders as they can better realize local problems and their opportunities, and can and will give much able assistance to our cooperators.

Another factor we have not overlooked in our woodland management program is the effect of woodland on flood control. This particular phase of the flood control program was emphasized at a recent meeting of the board of supervisors, and some valuable information was received at a meeting, attended by a part of our

board, of the Southern States Flood Control Board, held at Hot Springs, Ark., January 1941. Little did we realize that woodlands are the best binders of the soil and the best water reservoirs of all other forms of vegetation. With approximately 190,000 acres of woods draining into Black River, Spring River, Eleven Point River, Current River, and Fourche River, we feel that these woodlands have a real service to render in helping to protect the valleys from destructive floods. We shall do our utmost to instill into district cooperators an understanding of the value of proper woodland management. As of January 1, 1941, 39,564 acres of woodland are under agreement with the district.

The district has been assured of the able assistance of the WPA in 1941, now that most of the WPA projects on "Farm-to-market" roads are nearing completion in our district. We feel that WPA assistance on individual farms is just another link in the improvements of our national agricultural program. It is gratifying to the supervisors of the Tri-River Soil Conservation District to see that our Congressmen realize that there is no such thing as individually owned land, and that basically the Nation owns the land and the holders of particular tracts are only the lessees. By legalizing the use of WPA assistance to aid in conservation work on individual farms, Congress is merely enabling the Government as lessor to step in and help preserve its own property which has been sadly neglected by the holders or lessees who have allowed erosion to wash away valuable soil.

Since the soil is truly our first line of national defense, we welcome the assistance of the Government agency in helping us control erosion and establish permanent agriculture on what is actually the Nation's land leased to the individual.

While the WPA is helping the district in conservation work on the Nation's many farms, we hope our technical personnel in the district will accomplish much in teaching the WPA workers the principles of erosion control and good farm management practices. We know that many laborers now on WPA once farmed their own acreage and lost it through lack of knowledge of proper land use. We hope and believe that the WPA supervisory personnel will take particular pains to assign to conservation projects in the district those men who wish at some future date to return to farming themselves. The supervisors believe that this arrangement for WPA assistance will prove of mutual benefit to all concerned.

Since the supervisors made their last report, approximately 2,400 land owners with a total acreage of



Erosion has forced abandonment of many steep areas that should never have been in cultivation. Too riddled with gullies for pasture, this hillside has been planted to black locust, sumac, and wild plum. The trees and shrubs are to control erosion; black locust trees will do nicely for fence posts; all will provide food and protection for wildlife.

355,000, adjoining the present district, have voted, by an overwhelming majority, to be annexed to our district. The greater part of this new territory is considerably different from our original district. Previously our work has been largely with owners who farmed and lived on their own hill farms. Most of the annexation lies east of Black River and is composed of rolling to bottom lands of a sandy nature which erode very easily both from wind and water.

These farms are large and run more on a plantation style. Here, the majority of the actual farmers are tenants and thus our problem is partially one of landlord and tenant cooperation. We think this will not be difficult, however, as the landlords and tenants realize that it is to the advantage of both to have a long-time lease specifically incorporating erosion control and other farm practices advocated by the district's technical men. This will put the landlord's farm in better condition and will mean more money to the tenant. So we are looking forward to the district as a means of real help to the tenants and owners in this part of the annexation.

From opinions expressed by groups of farmers at recent meetings, it seems that most of the assistance to be requested will be of a technical nature. As we see it, farmers in the new area will need mainly engineering assistance in running strip crop lines, terrace and drainage systems, and agronomic assistance in working out proper cropping and management practices. On that portion of the area where the land is irregularly rolling and mounded, field strips probably will be one of the recommended practices.

Since this annexation is considerably different from the original district both in type of farming and

problems offered, we feel that we should attempt a little different method of approach on farm planning in the area, to try for a better solution of the farm problem. We intend to consider each problem area as set up by the county-wide planning committee as an individual unit. After the conservation survey has been made and before the farm planner starts to work on this area, we intend to call a meeting of the local representatives of the various agencies cooperating with the district. With the conservation surveys we can make a careful study of this area. Then, too, we can find out what each agency can do to assist in bettering the soil and economic life of these farmers. With this information, we feel that the farm planner can make a wiser and more complete plan.



Development of watering troughs below stock tanks is one of the approved practices in pasture development. The stock pond gets protection from contamination and from sedimentation. Ungrazed vegetation immediately above the pond stops the soil carried by water.

We intend to set up priority areas in which applications will be received. After the conservation surveys are made a meeting will be called for the farmers in that community. At this meeting will be explained the functions of the district, the part each agency will play in the district program, the land-capability table, and the district agreement. Each farmer will be given a conservation survey of his farm, colored according to the land-capability table. He will then have an opportunity to review the physical capabilities of his farm and will be able to draw up a tentative plan before the district planner contacts him for the drafting of the final plan.

In another section of our new area the picture is far from bright. We have three townships which present a question for which we have not yet found the answer. These are the townships of Annieville and Ravenden in Lawrence County, and Union Township in Randolph County. These three town-

ships, recently annexed, do indeed give us an economic problem. Practically no one of the small farm owners in these localities has the equipment or finances necessary to carry out even a partial erosion control program. Most of these farms are in such a critical stage of erosion that it is impossible for the owners to make enough income to support their families and they obtain part-time work on the WPA and elsewhere. The land is impoverished, resulting in an impoverished rural population. Here is a situation which truly needs remedying and with all the help now at the disposal of the supervisors we feel that in time we can bring a measure of relief to these special localities where it is so badly needed.

The board of supervisors desired information from people in every walk of life, and for this reason bankers, tax collector, county judge, stockmen, and many others were interviewed for the purpose of determining whether or not the soil conservation district was contributing in any way to the economic life of this community. We wish to quote the sayings of these persons, to wit:

I can see vast improvements made since the farmers have organized themselves into a soil conservation district. They take more interest in their roadsides, bridges, drainage water, and I can see it helps the county in maintenance of their highways in many ways.

REX JOLLY, *County Judge.*

JOE DECKER, *Former County Judge.*

Over 40,000 acres of land have been redeemed by original owners or purchased by individuals, and placed back on the tax books of the county since formation of the Tri-River Soil Conservation District.

BEN A. BROWN,
President, Randolph County Abstract Co.

I have been a livestock trader around Pocahontas for the past 30 years. I saw the pastures and meadows plowed up and put to row crops during the World War boom, and the resulting washing away of the topsoil, and the forming of gullies on most of the sloping fields. Probably no one can appreciate as I can the program of the Tri-River district in rebuilding pastures and meadows that were plowed up. Better livestock are increasing as the pastures and meadows improve, with increased income to the individual farmers, and naturally a greater volume of trading for me.

NOAH PACE.

Our forfeited land sales have become very light and few tracts have been forfeited to the State since this

district has been placed in a soil conservation district.

ROLAND MORRIS, *Tax Collector.*

In my opinion the formation of the soil conservation district, with local supervisors and community leaders, has played a big part in reducing loan delinquencies from 50 percent to approximately 5 percent since 1935.

ROY BENNETT,
Secretary-Treasurer, Local Federal Land Bank.

As a resident of Pocahontas, Randolph County, Ark., and acquainted with the Tri-River Soil Conservation District area, I wish to make this statement:

I am employed in the State Land Office at Little Rock, Ark., and in this capacity I have opportunity to note that over 75 percent of the land that heretofore has been forfeited to the State for nonpayment of taxes has been redeemed by the original owner or purchased by individuals. I attribute this to the soil conservation district.

JIM SHIVLEY.

At the local livestock sale in Pocahontas, today, approximately 3,000 head of stock were sold. This is a weekly sale and the increase in livestock definitely shows an increase in pastures. Buyers were present from north of St. Louis, Mo. The sales for the past week amounted to \$5,200. Amounts are not available as yet for today's sale.

H. G. McNABE

Dean Sallee, chairman of the board of stewards of the local M. E. Church, replied in answer to the question, Has soil conservation work affected the church collections? with the remark that this year the church budget was the largest for several years, and that the past year was the easiest for collections since he had been associated with that work; that he felt soil conservation work had helped increase the income of the town to make this possible.

In the approximately 3 years that the district has been in operation, not a single week has passed that our weekly county newspaper, the Star Herald, edited by Mrs. Eunice O'Baugh, has not carried from one to three columns about the work of the district. We wish to acknowledge this valuable publicity and to say that the cooperation of this editor and paper has been of inestimable help in the district's program. Besides these general columns, the paper frequently runs editorials commending the work of the district. At present the Star Herald prints a column headed "Out in the District" devoted exclusively to individual news items of work and happenings among the district's cooperators.

Having enlisted the active support of every agency, corporation and individual in our territory, we feel that the goal of permanent agriculture, founded on soil that will not wash away beneath our feet, will be reached.

F. W. COX, *Chairman.*
J. D. WELLS, *Vice Chairman.*
J. F. SLOAN, *Secretary.*
R. S. RAINWATER, *Member.*
J. B. WEAVER, *Member.*

Report of educational activities, July 1, 1940 to Dec. 31, 1940

Activity	This period	To date
Educational meetings:		
Number.....	23	362
Attendance.....	562	10,447
Tours:		
Number.....	0	11
Attendance.....	0	393
Demonstrations:		
Number.....	1	1
Attendance.....	65	65
Training school meetings:		
Number.....	0	0
Attendance.....	0	0
Exhibits: Number.....	2	5
Radio talks: Number.....	0	0
News articles: Number.....	41	276

Report of conservation practices, June 30, 1940, to Jan. 1, 1941

Agreements signed: This period—number, 287; acres, 33,257.5. To date—Number, 1,001; acres, 131,375.
Amendments: This period—Number, 132. To date—Number, 215.
Agreements canceled to date: Number, 9; acres, 1,702.

Practice	Before agreement		Newly planned		Established	
	This period	To date	This period	To date	This period	To date
Border strip.....acres..	0		4	27	0	5
Clearing and grubbing.....do..			23	29	0	6
Contour cultivation.....do..	2,402	5,220	2,402	10,407	2,174	3,067
Contour furrows and ridges.....do..	0	0	657	1,627	240	771
Controlled grazing.....do..	0	0	12,734	51,674	15,765	24,919
Cover crops (winter).....do..		203	1,304	4,579	2,294	3,087
Diversions.....rods.....	0	0	6,078	17,264	422	1,358
Drainageways:						
Individual outlets.....number..	0	0	356	2,480	23	159
Channels.....rods.....	0	0	3,611	9,014	307	2,054
Pasture and meadow strips.....acres..	0	0	53.2	211	12	59.5
Fencing:						
Constructed.....rods.....			28,637	116,437	3,751	15,973
Removed.....do.....			8,425	33,081	1,020	4,750
Fertilizing.....acres.....	0	0	160	1,175	30	816
Gullies treated.....number.....			5,975	26,329	266	3,161
Leveling old terraces.....rods.....			530	5,111	350	1,269
Liming.....acres.....			71	1,033	25	753
Pasture improvement.....do.....			5,185	10,094	1,863	3,051
Planting new pasture.....do.....			9,018	27,521	103	2,919
Planting old pasture.....do.....			3,056	10,037	150	1,445
Planting new permanent hay.....do.....			3,121	11,598	964	8,245
Planting woody vegetation.....do.....			52	338	37	125
Farm road treatment.....rods.....			3,389	13,661	761	1,402
Rotations approved.....acres..	6,346	11,186	3,346	14,927	5,287	7,921
Contour strip crops.....do.....			870	4,476	117	223
Structures:						
Gully.....number.....			394	1,550	31	402
Retention.....do.....			51	69	1	11
Capacity.....acre-feet.....			115	166.1	3.6	40.3
Fencing or fenced.....number.....			51	69	1	10
Spring development.....do.....			8	8	1	1
Terracing.....acres.....			1,185	4,254	138	1,380
Weed control.....do.....		78	11,361	28,221	2,089	8,220
Woodland improvement.....do.....				10		
Woodland protection.....do.....	5,430	24,080	4,430	14,315	7,445	12,231

Land conversion and ownership report, July 1, 1940, to Jan. 1, 1941

Land use	Before agree- ment	After agreement (planned)							
		Cultivated	Perma- nent hay	Orchard and vineyard	Pasture or range	Forest range	Woodland	Wildlife	Miscel- laneous
	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres
Cultivated land.....	30,122.5	19,704	6,122.5	158.5	3,913		23.5	15	186
Permanent hay.....									
Orchard and vineyard.....									
Pasture or range.....	14,396.5	679.5	1,131	30.5	12,169		198	40.5	148
Forest range or woodland pasture.....	6,612	4	13		3,169		3,204	5	217
Woodland.....	49,997	800.5	365.5	54	12,595		35,627	447.5	107.5
Wildlife.....									
Idle.....	28,595.5	2,192.5	4,397.5	80.5	20,700		512	319.5	393.5
Miscellaneous.....	1,630	20.5	17	60	70.5			3.5	1,458.5
Acres in agreement.....	131,353.5	23,401	12,046.5	383.5	52,616.5		39,564.5	831	2,510.5
Net changes.....		-6,721.5	12,046.5	383.5	38,220	-6,612	-10,432.5	831	880.5



Improper discharge of surface water often damages highways and public lands.

FARM DRAINAGE OPERATIONS FOR THE FARM PLANNER

BY JOHN G. SUTTON¹

IN bringing drainage into the Soil Conservation Service program many farm planners are meeting a new problem. Some may question how and where drainage fits into a conservation program. To answer this question we must think of drainage not as an end itself, not as a means to speculative land development but as a tool of the soil-conservation program to be used in securing proper use of each acre of land. With this as a general objective, we must apply additional criteria to drainage proposals. Some drainage projects involve soils well adapted for sustained agricultural use, while on others the soils drained are submarginal under existing agricultural conditions. Some drainage jobs are not economically sound; others would be financially sound even without Government assistance or with limited assistance. These criteria may be applied on a farm basis, or to land areas involving few or many farms.

When the farm planner encounters a drainage problem on a farm he must be able to determine its relation to the soil-conservation program, know the effects of drainage on the land, and be able to offer practical solutions to the problem. Drainage of an area may bring into cultivation land not previously cultivated, and on most soils it will improve the productivity of land that has been farmed while inadequately drained. This means increased crop yields to the farmer so that drainage becomes an economic benefit to him and, usually, he will want to secure as much help as possible in draining his wet lands. Some farmers have not had first-hand experience with artificial drainage and its benefits must be explained to them in detail.

Drainage operations contribute directly to the success of erosion-control practices in a number of situations. Probably the simplest to interpret is the physical land problem, or topography, that requires drainage operations to facilitate the application of one or more farm-conservation practices. Three examples of this type of problem are described below:

- (1) Tiling of wet spots on a farm is necessary to permit contour cultivation, strip cropping, or terracing.
- (2) Spots that become wet as the result of terraces or diversions should be drained.
- (3) A drain through bottom land is necessary in order to avoid damage from concentration of water in a terrace outlet or diversion.

Other situations, more complex in nature, include economic considerations which relate drainage operations to erosion control practices as an integral part of farm-conservation plans. The following brief descriptions point out these situations:

- (1) Draining or improving the drainage of one part of a farm is necessary to permit the retirement or change to soil-conservation use of a steeper portion of a farm, or to retire land not adaptable to conservation farming.
- (2) Drainage is necessary to improve the farm unit or make it sufficient from an economic viewpoint in cases where the farm is not an economic unit after other conservation practices have been applied.

Many drainage problems cannot be solved on a single-farm basis. These often involve outlet or overflow difficulties common to small or large groups of farms. Such problems should be recognized and plans for their solution ought to be developed along with farm planning.

¹ Head, drainage and irrigation section, engineering division, Soil Conservation Service, Washington, D. C. The article presented here does not include discussion of drainage of irrigated lands.

In incorporating drainage into a farm plan its effects on the land and on farming operations should be clearly understood, as should also the connection between effects and degree of drainage obtained. For convenience, degrees of drainage may be expressed thus: The term *excellent drainage* may be applied to land with fine underdrainage (usually tile-drained) and not subject to overflow except possibly in an exceptional flood, say with not less than a 25-year frequency. *Very good drainage* means good underdrainage, and flooding at 3- to 15-year intervals during the cropping season but for such brief periods that crop damage is not great. *Good agricultural drainage* connotes flooding possibly once annually for so short an interval that no extensive crop loss will occur. The surface and underdrainage are sufficiently satisfactory to permit production of good crops in normal years, while only in wet years will crop losses due to inadequate drainage be evident. *Fair drainage* signifies the degree of drainage wherein flooding will occur several times annually in normal years and partial crop losses may be expected once in 3 or 5 years, with only fair crops in a normal year. Lands having "fair" drainage may be well adapted for use as pasture or meadow.

The degree of drainage is controlled by engineers by construction of larger and deeper drains where "excellent" and "very good" drainage are required.² If drainage systems are not properly maintained the lands will in time become poorly drained, usually because open drains become clogged with bushy vegetation and silt.

The improvement of farm drainage often indicates a change in land use. For example, it may be desirable to change a poorly drained field or swamp to pasture by providing "fair" drainage, or it may be desirable to change the land use of a pasture area to cultivated field crops by providing "good" agricultural drainage. In planning a farm the farm planner should specify the land use so that the required degree of drainage may be provided insofar as practical.

Other effects of drainage must be given careful attention by the farm planner. It is well established that some legumes do not tolerate high-water-table conditions. We often hear farmers who are working on poorly drained soil make statements such as the following: "Clover will not grow on soggy soil"—"Liming is nearly useless until the soil is properly drained."—"Alfalfa won't do well on wet fields." Such remarks indicate the bad effects of poor drainage on legume crops. Those soil bacteria which inoculate

legumes to change air nitrogen into fixed soil nitrogen, so it can be used by the plants, will not thrive in a wet soil. The legume plants take a large amount of nitrogen from the air, working in symbiotic relation with these bacteria. It is evident that complete aeration of root zones is even more important for some legumes than for other crops. However, other legumes, such as soybeans, do tolerate wetter soils. Since legumes are generally fundamental to a soil-conserving rotation, it is evident that drainage conditions must be given careful study in developing the cropping rotation of a farm plan.

Another effect of poor drainage is the winter kill or injury of plants that go through a winter. Where soil is saturated the recurring freezing and thawing often pushes individual plants almost out of the ground so that they are killed or injured. Poorly drained spots in wheat and alfalfa fields can be picked out in the spring because of the effects of winter kill.

Good underdrainage is of primary importance and may be secured even on some of the heavier clays by tile drains. Underdrainage results in a lowering of the water table and this sets in motion many beneficial processes: Water leaves the soil earlier in the spring so that fields can be plowed and planted; in a well-drained field the percent of seed germination is higher and the resultant stand is superior.

Good drainage, with proper rotations and cultivation, means good tilth to the soil. Good drainage permits cheaper cultivation. In poorly drained fields, farm machinery must go around wet spots and this brings up the cost of cultivation. The well-drained field has a deeper root zone and also better aeration of the root zone, a condition essential to proper plant growth. The deeper root zone permits a stronger and healthier plant, one that generally is better able to withstand drought. Although it seems almost paradoxical it is quite true that in drought years on clay and clay loam soils farmers usually secure best yields from fields having the best and deepest drainage. Tile drainage is recognized as a profitable investment, so much so in fact that bankers often will lend money to enable the farmer to adopt the practice and thereby increase his yields.

Although it is difficult, if not impossible, to over-drain heavier soils, caution must be used in draining peat, muck, sandy, and sandy loam soils. These soils are low in water-holding capacity, and lowering the water too far beneath the surface may result in drying. The sandy soils are subject to wind erosion, and the peat and muck soils to blowing and fire if overdrained. Improper drainage of these soils may cause widespread

² See article, *Hydraulics of Open Ditches*, by the author, in *Agricultural Engineering*, May 1939, for further discussion.



Typical "before" condition of land that is to be drained.

damage, as in the Florida Everglades. In Indiana and Michigan controlled drainage by means of gate structures in ditches has been attempted in level areas of peat and muck soils with considerable success.

In many instances underdrainage is a direct benefit to soil conservation and erosion control. Underdrainage means the establishment of underground channels of water through which the ground water will flow and run off through tile drains. All the water that flows through the soil is conducted in a manner that is nonerosive. A well-drained field has better tilth and can absorb more rainfall. If a field is not underdrained any excess surface flow causes loss of soil through erosion. Such erosion is often serious, even on gently sloping fields that should be tile drained.

A well-drained field also conserves soil resources in still another way. The soil is not a dead, inert substance, but is teeming with living bacteria and organisms necessary and conducive to plant growth. Where poor drainage conditions exist and the water table is too near the surface, or where water "ponds" in fields after heavy rains, the situation is not conducive to efficient plant growth. The flooding of the soil drowns these bacteria, organisms, and plants and disturbs the equilibrium so that it may take a long time to rebuild a productive soil of good tilth. In considering the relationship of drainage to other phases of a complete farm program it is evident that proper drainage goes hand in hand with soil building and proper crop rotations.

The benefits of good drainage by way of sanitary conditions should not be overlooked. In some States the malaria-carrying *Anopheles* mosquito breeds on wet spots, but malaria can be prevented or reduced in rate in many places through proper drainage. Public-

health benefits constitute one of the principal justifications for public support and interest in drainage activities. The proper drainage of feed lots is conducive to better health of farm animals. Good drainage of the farm homestead is essential for sanitation and clean living of the farm family.

The benefits of drainage often are well understood by the farmer, although occasionally it is desirable that he be furnished information on the beneficial results of underdrainage. Farmers themselves usually can provide excellent information on the effects of drainage on various crops on their farms. For example, they can tell the farm planner which fields are poorly drained, which spots flood out and approximately how often. Frequently, however, the farmer is at a loss in recommending a solution. He may attribute his drainage troubles to one cause when in reality there are several. He may claim that his drainage troubles are the result of the clearing out of ditches by farmers upstream, when in reality the drains serving his farm are inadequate. He may believe that his drainage difficulty is due to constriction of a ditch at one point and that he can relieve the situation by improving the channel for a short distance. In some instances this may be practicable but usually a more complete solution is needed than is apparent from a casual examination. Often the entire drainage system must be rehabilitated. Overestimating the adequacy of an outlet channel is another common error; frequently more extensive improvements are needed on the outlet channel than is realized by those affected by poor drainage conditions.

The experience of the writer, in dealing with farm drainage problems, is that although accurate information usually can be secured from the farmer as to the effect on crops of drainage practices and specific fields needing drainage, yet considerable caution must be

used in accepting remedies suggested by the farmer. This is of course in the nature of personal observation; other observers may have had other experiences.

The farm planner should become familiar with some of the fundamentals of planning for adequate drainage systems. An adequate outlet is the first essential. The outlet may be an artificial ditch or a natural channel. In either case, the capacity in relation to the watershed, the height, and frequency of floods should be considered. Recommended drainage curves have been supplied to each Soil Conservation Service region for general use, but it should be understood that where the watershed contains steep lands the rate of run-off will be higher and flooding will be more frequent. Often the adequacy of an outlet can be checked by determining from local residents the maximum flood heights, and by getting all information available regarding flood frequency. If the land to be drained lies slightly above the average annual flood heights of the outlet stream it is possible, ordinarily, to secure "good" agricultural drainage by providing adequate farm ditches to that outlet.

The farm planner will be called on to decide whether drainage should be provided by means of open ditches or by using tile drains. Some authorities contend that underground water will not flow off through open ditches as well as through tile drains, but evidence on this point is not conclusive. Except for higher first cost, tile drains generally are much superior to open drains for farm drainage. The chief disadvantages of open drains as compared with tile drains are that they cut up fields, occupy land that could be farmed, make cultivation more difficult, and entail maintenance problems. In some soils tile drains thus far have not proved economical; in such soils their use should be on a demonstrational basis until it is determined whether or not they can provide proper drainage.

Many soils are porous enough and have sufficient internal drainage so that underdraining is not absolutely necessary if good surface drainage is provided. In case of doubt it is advisable to try surface drains, with possibly a few lines of tile, until the economy of tile underdrainage is determined.

When using either tile or open drains on slightly undulating land it is often economical to plan the system so that the low swales are drained with random drains, which are less expensive than drains laid at regular intervals. In locating a drain it is a fundamental rule that it should be placed along the lowest points of a field.

Field ditches may be of the following types:

(1) Narrow ditches with nearly vertical sides, dug and maintained by hand.

(2) V-shaped ditches 2 to 3½ feet deep, dug and maintained by equipment such as a ditcher or grader

(3) Wide flat ditches in meadow crops, so constructed that they can be readily crossed by farm equipment.

(4) Larger drains which are dug by dragline excavators; such drains are economical where a medium-sized ditch is required.

Drains of poles, brush, stones, and lumber were used in early days for underdrains and all evidences point to the fact that the benefits of proper drainage were understood by early pioneers. The length of life of such drains was usually short, although occasionally some are discovered which are still operating. For at least 80 years tile drains have been the common type of underdrains and during this time the quality has been much improved.

An adequate outlet is particularly important for a tile drain. The ideal outlet permits free flow from a tile drain at all times, but this can seldom be secured. The farmer who is undertaking tile drainage should be certain that the outlet will not deteriorate or else that satisfactory provisions will be made for maintenance. Tile drainage is an expensive farm improvement and the entire investment may be lost if the outlet is not maintained.

Tile drainage is often successfully and economically established on farms by employing a random system following low spots. On flatter fields of heavy soils a random system may not be practicable, so that regular spacing of drains is necessary. In clay and clay loam soils that are successfully drained the tiles are placed from 40 to 70 feet apart and from 27 to 36 inches deep. No tile should be laid less than 27 inches deep. In lighter soils, the spacing may be as great as 150 to 200 feet and the depth as much as 42 inches. The tile system usually is designed to handle a run-off of one-quarter or three-eighths inch from the watershed area in 24 hours.

For the benefit of farm planners in particular, a general method of determining proper depth and spacing of tile drains based on soil analysis is badly needed, but unfortunately no index based on a sufficient number of soil types to justify widespread application has been worked out. Until some such method is developed we should attempt to build up the fund of factual material relative to the effectiveness of drains for the various soil types in each locality. Tile drainage has been widely used, and extensive systems have been installed with varying degrees of success.

Farm planners handling drainage problems must ferret out available information to apply to the soil types he encounters. Often the State Agricultural College is the best source of information regarding local drainage practices. Many State colleges have men who have been dealing with drainage problems for long periods of time; often their fund of information is very helpful.

The maintenance of an open ditch is the key to successful drainage of the farm lands it serves. All open drains deteriorate gradually, and thus they must be maintained effectively and regularly if farmers are to benefit through proper drainage. Poor maintenance results in large annual crop losses, and herein lies one of the difficult problems in connection with drainage systems. Much information is yet to be secured on proper drainage practices, but in spite of this deficiency the farm planner can pass on to the farmer many ideas for improving maintenance to keep the farm drainage system functioning properly. Some of these ways and means for recommendation by the farm planner are discussed in the following paragraphs.

In many places large open drains serve so many farms that it is impracticable for individual farmers or groups of farmers to maintain them. Such drains must be maintained by a legal drainage enterprise or as provided by State law. Drainage officials or county officials responsible for maintenance of such drains are subject to the wishes and demands of the farmer, so that if the farmers insist on proper maintenance they will get it. If a farmer is content to neglect maintenance, in order to save annual taxes, officials may allow these large open drains to go without maintenance. The farm planner can assist in making the farmer aware of his drainage problem so that he will insist on public maintenance of outlet drains when it is needed.

Several practical methods of decreasing the silting of ditches have been tried out and found successful. Formerly it was common practice to allow field drains to run into open ditches at low level without protection at the point of drop, and this resulted in silt deposits and often in gully-type erosion. The improved practice used today is to establish vegetated runways at all points where surface water enters a ditch; where special problems must arise structures should be provided to avoid such erosion. Spoil banks should be placed well back from the edge of the ditch, and they should be leveled if the soil is suitable for cultivation and fits in with the farm plan.

On many farms there is considerable erosion on slopes of 1 to 3 percent. Farm planners should give this type of problem careful attention, as such areas often represent a farm's most valuable agricultural lands. It may be desirable to work out an erosion-

control plan for such lands, not only to hold the soil in place but to try to reduce erosion debris to a minimum as an aid in economic maintenance of the drainage systems. A system of field drains with wide shallow sodded ditches may be used to minimize the silting of ditches. Open drains should be grassed, and controlled pasturage often helps in maintaining them. Where maintenance of drains is the direct responsibility of the farmer, the farm planner should help him to work out specific measures for keeping his drainage system in good condition as a part of the farm-conservation plan.

DISTRICT NOTES

The supervisors of the Kent Soil Conservation District, Md., consider drainage, bay-bank and shoreline erosion-control problems along Chesapeake Bay as a part of district work. This involves control of roadside erosion and erosion in adjacent fields caused by concentration of water drained from roads. In their last semiannual report the supervisors make this statement: "Both of these problems are worthy of effort * * * Treatment of shore line erosion would be largely experimental work to determine the most economical and effective means of prevention and control. Relative to roadside erosion, it is felt that closer cooperation with the State Roads Commission would improve the situation and some present erosive conditions could be reduced or eliminated."

The supervisors of the Fort Berthold Soil Conservation District, N. D., have purchased 160 acres of land from the commissioners of Mountrail County for the purpose of grass-seed production. Of course, the seed produced on this land will be used on farms in the district that are covered by a farm conservation plan and cooperative agreement between the respective farmers and the supervisors. The supervisors now hold a tax deed to this farm, the title to which will be cleared without cost to the district by the State's attorney of Mountrail County.

The governing body of the Leake County Soil Conservation District, Miss., recognizes the "need for some sort of a drainage program to help farmers open up some of the good land on 'A' slopes so that they could retire submarginal slopes with greater ease and security" and are working toward such a land-use adjustment program in connection with district work.

LAND RECLAMATION AND PASTURE INVESTIGATIONS ON ABANDONED AND SCRUBBY OAK AREAS

By HARRY M. ELWELL ¹

BECAUSE of erosion a high percentage of the cultivated fields in central Oklahoma (2, 10) are being abandoned. For this reason land-reclamation and pasture studies have been carried out within the past 8 years on a typical area of the cross-timbered section (7) of the State. These investigations were started in 1932 on about 110 acres of land leased by the Oklahoma Agricultural Experiment Station and operated cooperatively by the Soil Conservation Service. The area lies just east of the main farm at the Conservation Experiment Station near Guthrie. About 75 acres of this land was abandoned, and the remainder was covered with native scrubby oak and grass. An erosion survey showed that about 12 inches of the surface soil had been removed from the abandoned area during approximately 37 years of continuous cultivation. Various reports (5, 9) show results of the earlier findings, and the revegetative and gully-control experiment conducted on the abandoned portion was reported by Elwell, Slosser, and Daniel (6).

According to recent land-use information (11), 32.15 percent of the pasture land in Creek, Lincoln, Okfuskee, Seminole, Cleveland, Oklahoma, Pottawatomie, Pontotoc, and Coal Counties in Oklahoma is classed as woodland pasture. In eight townships of southeastern Logan County, woodland pastures occupy 47.22 percent of the total farm lands. The tree cover in the cross-timber area of the State consists mainly of blackjack oak (*Quercus marilandica*) and a small amount of post oak (*Quercus stellata*). This wood cover occurs in sparse to rather dense stands on land between the creeks and drainageways. The first photograph shows that usually this vegetation is intermingled with dense spots of native grass. These grasses make a very good growth where the tree competition is not too great.

The land-reclamation studies involved, first, the removal of scrubby oak from about 35 acres of this type of land in 1935-36. The cost of clearing such land is quite high although it varies, of course, with density of the stand. However, farmers adjacent to the station found that 10 to 16 ricks of firewood per

acre were produced on similar land and that under average conditions such materials bring from \$1 to \$1.50 per rick. Thus it is thought that in most instances the return from the sale of the wood about meets the cost of removing the trees from the land.

After the original cover was removed, it was found that sprout growth from the stumps must be controlled. Burning these sprouts with kerosene torches was tried, but the cost was found to be approximately \$3 per acre, and the practice also destroyed the grass around the stumps. Then the effect of goat grazing was observed on an adjacent farm and in this one instance it appeared that the herbage vegetation was so utilized along with the sprouts that the practice seemed to retard grass succession on the land formerly occupied by trees.

Several other methods also were tried out in efforts to minimize unfavorable competition by oak sprouts and at present clipping with a regular farm-type mowing machine appears to be the most satisfactory. This practice has been recommended by Aldous (1) in Kansas for controlling weeds and brush in pastures. He states, "This work was more effective when it was done at the low point of the organic food reserves." According to his findings this condition apparently occurs during the first part of May for a large proportion of the common weeds. The Agricultural Adjustment Administration (12) has approved payment of 25 cents per acre for mowing of noxious plants as an aid to range and pasture management during 1940. Although some sprouts remain at present, there has been little or no competition from the oak plants where mowing was done about the middle of May and again the latter part of August. This indicates that the sprouts may be clipped at the same time the weeds and other noxious plants are mowed, without additional expense.

After the tree competition had been removed, the grass soon spread and provided a ground cover sufficient to prevent erosion. Evidence of this is seen in the fact that an average annual run-off of 1.23 percent was recorded during a 5-year period from a 2.5-acre watershed within the recently cleared area.

It is thought advisable that the cleared areas be used as a meadow for a few years, in order to minimize the

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Typical area of scrubby oak trees intermingled with native grass on the central cross-timbered soil of Oklahoma.



The seed produced by native grasses under favorable conditions will often spread and produce a good cover the first or second year after removal of scrubby oak competition.

likelihood of overutilization of the vegetation. If the grass is cut for hay early in August, most of the native plants will set a fair crop of seed before the season of frost in central Oklahoma. The information already obtained indicates that if the areas are protected from fires a good ground cover of native grass and enough forage to permit some grazing may be produced in 2 to 3 years under normal rainfall conditions.

According to the best information available (6), it may take about 25 years or longer for the native climax grasses to reestablish themselves under natural conditions on abandoned land. This no doubt is due largely to low fertility, low water-holding capacity, and the poor physical condition of the subsoil exposed by erosion. Revegetative experiments with light application of fertilizer on rowed sweetclover have been encouraging on the abandoned land. Lime was applied at the rate of 100 pounds per acre and either rock

phosphate or superphosphate at the rate of 50 pounds per acre. The seed was sown in rows 3 feet apart. The yield of clover the second year was about a ton of forage per acre. In some trials a fair stand of blue grama was obtained from broadcast seeding at the rate of 20 pounds per acre following the sweetclover. This plant was the only species of 18 native grasses that produced a fair ground cover during 1936 and 1937.

In 1939 the entire farm of 110 acres was converted into a grazing experiment in cooperation with the Oklahoma Agricultural Experiment Station. Although the soils and plants on the virgin land were slightly higher in nitrogen and minerals than those on the eroded area (see table 1), in general the type of vegetation occupying this section of the State (3, 4, 8) is low in phosphorus and calcium. Since these elements are very essential in the growth of livestock, a mixture of equal parts of steamed bone meal, pow-



Grass cover the third year after removing scrubby oak, and after being grazed 119 days by 14 yearling steers.

TABLE 1.—Quantity of grass consumed in summer grazing by steers, and analyses of vegetation and soils from submarginal areas and cleared woodland

Type of land	Year*	Total plant cover consumed by cattle	Analyses**					
			Forage	Soil				
			Nitrogen	pH	Organic matter	Calcium	Magnesium	Available phosphorus
Abandoned (formerly cultivated about 37 years).....	f 1939 1940	Percent 10. 19 25. 20	Percent 0. 468	7. 20	Percent 0. 73	Medium.....	High.....	Very low.
Woodland (cleared 1935-36).....	f 1939 1940	20. 79 67. 12	. 625	7. 44	1. 04	High.....	High.....	Very low
Virgin meadow.....	f 1939 1940	None	. 657	6. 28	1. 29	High.....	Very low.....	Very low.

*During 1939, 14 steers were on pasture 119 days; in 1940, 20 steers, for a period of 153 days.

**Forage and soil analyses made by Agronomy Department, Oklahoma A. and M. College, Stillwater, Okla.

dered limestone, and common salt was provided at a convenient location for the cattle. The animals used in the grazing tests ranged from medium- to good-quality yearling steers.

The original plans included grazing the pasture during the growing season, but because of delay in getting the experiment under way the first year, it was not until June 6, 1939, that 14 grade yearling steers were turned on to this farm to remain until October 3, a total of 119 days. The data in table 2 show a total gain of 2,716 pounds for all the steers, which is an average of 24.68 pounds of beef per acre. The average gain per head was 194 pounds, which is an average daily gain of 1.63 pounds per head. During the second test, in 1940, 20 steers occupied the same pasture from May 1 to October 1, or 153 days. They produced a total of 5,530 pounds of beef, or an average gain of 276.5 pounds each, which is a daily gain of

1.81 pounds per animal. This is an average of 50.27 pounds of beef per acre.

Several wire cages were placed over areas of the pasture, and the vegetation utilized by the steers was calculated by comparing the amount of grass in the protected areas to that in the grazed areas. The percentage of total plant cover consumed by the cattle

TABLE 2.—Gains made by yearling steers grazed on 75 acres of land formerly abandoned from cultivation, and 35 acres of cleared scrubby woodland* (Progress report, 2 years only)

	1939**	1940***
Number of animals.....	14	20
Grazing period..... days..	119	153
Acres per steer.....	7. 86	5. 5
Selling weight (Oklahoma City)..... pounds..	9, 072	15, 330
Initial weight (Oklahoma City)..... do..	6, 356	9, 800
Total gain in weight..... do..	2, 716	5, 530
Gain per acre..... do..	24. 68	50. 27
Average daily gain per steer..... do..	1. 63	1. 81

*Data collected by Bruce R. Taylor, assistant professor of animal husbandry, Oklahoma A. and M. College, Stillwater, Okla.

**Grazing period, June 6 to Oct. 3.

***Grazing period, May 1 to Oct. 1.

in 1939 on the eroded portion was 10.19, and on the virgin land 20.79; while the consumption in 1940 was 25.20 and 67.12 percent, respectively.

It should be realized that in the first test the steers were placed on the pasture at least 40 days after the grazing season had started. These same steers had no doubt been on grass somewhere during this period and had made some weight gain thereby. The low utilization of vegetation indicates that a heavier stocking than 7.86 acres per steer might have given greater profit. Because of this the number of animals was increased the second year to 5.5 acres per steer. From observation and the amount of vegetation consumed, it appears that the carrying capacity of the pasture was reached under its present conditions.

When the amount of beef produced per acre and the variation in the price of cattle the last few years are taken into consideration, it seems probable that a gross income of \$1 to \$4 per acre might have been received. This is a fair return, considering the fact that such land has an average sale value of approximately \$8 per acre. In any event, the fact remains that the average pounds of beef per acre produced by medium- to good-quality yearling stockers was increased from 24.68 in 1939 to 50.27 in 1940, an increase sufficient to place this formerly useless land on a profitable basis of operation.

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PLANTING LESPEDEZA SERICEA WITH BLACK LOCUST

By J. A. JOHNSON¹

THE growing of two types of plants on a single area with the desired results and without injury to either is unusual, but such a planting is especially worth while if it helps the farmer to solve a land-use problem in a practical way. This article tells briefly of successful demonstrations in the growing of black locust (*Robinia pseudoacacia*) and *Lespedeza sericea* on Mississippi farms in two erosion-control demonstration projects and one CCC camp area.

The Soil Conservation Service has long recommended the planting of black locust on eroded lands in the Southeastern States for control of erosion and production of durable fence posts. On Mississippi farms where fence maintenance is a part of the soil conservation plan it has been the practice to devote to black locust 1 acre out of every 100 acres of such land. In this way the farmer could produce sufficient fence

posts without incurring an excessive labor load or an oversupply of posts. The same general rule is now being followed by farmers in Mississippi soil conservation districts.

In the spring of 1936 a number of locust areas on farms in the Oakey Woods Creek demonstration area near Laurel, Miss., were interplanted with *L. sericea* in an effort to improve the ground cover and increase the variety and quantity of food for wildlife. The plantings gave indications of ultimate success the first season, but there were several questions to be answered before foresters and biologists were willing to recommend the combination generally. Is the planting of *L. sericea* with locust an improvement over planting locust alone for the control of erosion? Does *L. sericea* compete with locust for moisture and plant food to the detriment of the latter? How long will *L. sericea* be able to maintain itself under a rapidly developing locust stand? Is wildlife habitat im-

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A combination of black locust and *Lespedeza sericea* provides better erosion control, adds shelter and food for wildlife. This is how the two look in the third growing season. Although not evident in this picture, a complete stand of sericea spreads to the middles as a result of natural reseeding.

proved by planting *L. sericea* with the trees?

In order to obtain more complete answers, the author and project foresters established an additional number of these combination areas on farms in the Hell and Mud Creeks demonstration project near New Albany, Miss., in the spring of 1938. Almost without exception, good stands of both plants were successfully established.

A study of these areas over a 3-year period, and intermittent observations of the older areas in the demonstration project at Laurel and the CCC-camp demonstration area at Collins, appear to justify the following conclusions:

(1) *L. sericea* with locust improves the erosion-control value of the planting because a close ground cover is more quickly obtained. This is particularly true in winter when the heavier leaf mulch of *L. sericea* is needed to supplement the very light locust mulch.

(2) Locust does not suffer in growth as a result of competition from *L. sericea*. In fact, the opposite appears to be true. At New Albany where the areas were closely evaluated, locust plantings containing *L. sericea* are as good or better than those without it.

(3) *L. sericea* is maintaining itself in 3- to 5-year stands of locust with a vigor indicative of a long existence, possibly even to the point of permanency.

(4) As to whether or not the areas actually offer an improved wildlife habitat, it is apparent that a careful census of treated and untreated areas will be necessary before an authoritative statement can be made. The observations indicate, however, that the black locust-*L. sericea* areas are useful to rabbits,

quail, and small birds. It was reported that quail made good use of the areas in the Laurel project during the nesting season.

Several methods of establishing the plants in combination have been tried. The most practicable involves contour beds thrown up at 6-foot intervals when the land is prepared for tree planting. The beds are made by opening a furrow with a turning plow and then bedding back on this open furrow with at least two complete rounds with the same plow. This gives a firm, deep bed with no air pockets after it has been settled by one or more soaking rains. The young locust seedlings were set 6 feet apart in the center of the firmed bed. If they were set before March, the *L. sericea* seed was sown at a later date; if planted during late March or early April, the *L. sericea* was sown immediately following the tree planting. A very shallow trench was made with a hoe along the top of the bed between the trees so that the seed could be confined to a narrow strip. The *L. sericea* was sprinkled in this drill in the same manner as turnip seed is sown, except that they were not covered. About 2 pounds of scarified seed was used for each acre of trees.

Later in the spring, when the trees first began to send out feeder roots, a furrow was opened on each side of the planted bed. Compost or commercial fertilizer was spread in these open furrows and covered by plowing out the middles between the beds.

Cultivation for one or more seasons, and fertilization, are essential on most soil types to ensure adequate growth of locust, even on less-eroded soils. Because of this, the method of planting described above has

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PROTECTING THE BACK SLOPE OF INTERCEPTION DITCHES

By CHARLES B. SULLIVAN ¹



An example of sod waterway construction, from temporary furrow to bottom of diversion ditch.

STABILIZING the back slope of interception ditches frequently presents a difficult and often discouraging problem to both agronomists and engineers. Interception ditches invariably are located in exposed sites on slopes. When the raw surface of a newly constructed ditch is subjected to rains of any notable intensity, the back slope becomes rilled and often the channel of the ditch becomes silted. The severe rilling of a newly seeded back slope necessitates reseeding under unfavorable conditions and sometimes the process of seeding has to be repeated several times before a stand of vegetation can be established.

Of equal seriousness is damage to the designed cross section of the ditch by rilling, silting, and scouring. However painstakingly designed or effectively constructed a ditch may be, a single intense storm while the ditch is unprotected by vegetation may cause a serious modification of the cross section and lessen considerably the effectiveness of the structure. Also, in such circumstances the discharge of silt from the unprotected site augments the silting damage to streams lower in the watershed.

A system for intercepting run-off from the slope above ditches, to prevent rilling of newly seeded back slopes, has been effectively and extensively used in Lancaster and York Counties, Pa., since the summer of 1938. A small gutter is constructed at the junction of the back slope and the filter strip, and intercepted run-off is vented over sod inlaid in the back slope into the main ditch channel.

When the construction of a ditch has been completed, the gutter is made by using either a plow or a terracing blade. The former has the disadvantage of leaving a land side that will tend to slough, while the latter effects a well-rounded upper side that will handle run-off with the least amount of soil loss. Passing a spiked plank harrow over the gutter insures a satisfactory seed bed.

The continuity of this back-slope gutter is interrupted at intervals by sod outlets inlaid in the back slope at strategic points. Oftentimes such sod waterways down the back slope are necessary whether or not this method is used, as for example where an old gully concentrates water that would continue to cut into the back slope of the ditch. By means of these sod outlets at intervals of approximately 200 or 300

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feet, run-off is discharged safely into the main channel of the diversion ditch.

The accompanying photograph shows the broad details of construction of both the back slope gutter and the inlaid sod waterway down the back slope to the channel of the ditch. It will be noted that the sod waterway does not continue across the channel but extends only about 18 inches into the channel. This extension is sufficient to break the force of water entering the channel over the sod and eliminates the

dam and over-fall effect caused by sodding completely across the channel. As can be seen in the picture, ample protection is afforded this ditch by the gutter. The ditch was seeded September 13, 1938; the photograph was taken early in the Spring of 1939. Several severe storms had been experienced in the interval.

In addition to giving protection to back slopes while vegetation is becoming established, this system is valuable to prevent silting when filter strips are plowed for renewal.

A SAFER USE OF LAND

MORE proof is accumulating that silage from perennial soil-building forage crops such as alfalfa and timothy is cheaper than silage from corn, a soil-depleting crop. During 1936-37 northern New Jersey corn silage, yielding 11 tons per acre, cost \$4.97 per ton to produce; timothy silage yielding 7 tons cost \$2.17 per ton; and clover and timothy silage, yielding 9 tons, cost \$3.11 per ton. In addition the corn silage cost \$2.07 per ton to harvest, while the grass silage cost only \$1.85 per ton. Including 60 cents per ton for molasses, the grass silage was still considerably cheaper than the corn silage and its feeding value was higher. The carotene value of the timothy silage was higher than that of the best dehydrated alfalfa hay. Dairy heifers thrived on a sole ration of this timothy silage, gaining an average of two-thirds of a pound a day per head. The experimental work was done at the Sussex branch of the New Jersey Experiment Station.

Since some are of the opinion that such data may not apply to the Corn Belt, it is very important to note that in 1939 the Ohio Agricultural Experiment Station obtained data from 120 farms in comparing the cost of producing alfalfa, soybean, and corn silage. First cutting of alfalfa, averaging 5 tons of silage per acre cost 50 cents per ton prior to harvest and \$2.19 for harvesting. The additional charge of 60 cents for adding 50 pounds of molasses per ton, made a total cost of \$2.69 per ton.

The cost of producing an acre of alfalfa was \$9.15, of which \$6.67 was charged to the second and third cuttings which were used for hay. Soybeans yielded 7½ tons of silage per acre which cost a total of \$3.91 per ton including molasses. Corn, yielding 9 tons per acre, cost \$1.95 to produce and \$1.19 to harvest, making a total of \$3.14 per ton or 17 percent more than the alfalfa silage.

In addition to the cheaper cost, the grass and legume silages have the advantage of a higher protein content and of being soil-building rather than soil-

depleting crops. It is not unusual for molasses to sell at prices which put it on a competitive basis with corn. Hence, the molasses might be considered as an added value rather than as a charge against the alfalfa.

The making of silage from perennial grasses and legumes fits admirably into the trend toward grassland farming and meets the urgent need for cheaper methods of producing meat, milk, and other livestock products. With good management and the use of sufficient mineral fertilizers, productive silage meadows can be maintained on land that presents many difficulties for clean-tilled or other annual crop farming. Likewise, in some instances the making of silage from grass will permit the advantageous use of longer rotations such as 1 year of corn, 1 of small grain and 3 or 4 years of grass. Numbers of fields in grass also facilitate rotation grazing in addition to supplying hay and silage for winter feed and other periods when grazing is not adequate to supply livestock feed.

Additional information on this subject may be found in New Jersey Circular 374, entitled "Timothy Silage as a Dairy Feed," and the July-August 1940 issue of the Ohio Bimonthly Bulletin.—A. T. Semple.

LESPEDEZA SERICEA—BLACK LOCUST

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several advantages over broadcasting seed on the beds just after the trees have been set, or sowing in the middles following cultivation. In the first place, the *L. sericea* is given an equal start with the trees without handicapping cultivation of the latter. Early sowing is desirable to ensure satisfactory establishment of *L. sericea* during the first growing season, particularly because it is a slow-maturing perennial. Second, less seed is needed for this method; and in the third place, the ground cover obtained is sufficiently dense to reduce run-off, yet not so rank as to compete seriously with the young locust trees for moisture and plant food. *L. sericea* begins seeding into the middles after cultivation is discontinued, but the indications are that the ground cover will never become so dense as to be objectionable to wildlife.



KUDZU, A SOIL BUILDER

By R. P. Bartholomew ¹

KUDZU is a good soil-improving crop where it is adapted to the environmental conditions. Just what limitations exist in its adaptability and what special precautions must be taken in establishing and handling the crop still appear to be a matter of personal preference and experience.

Although experiments with kudzu in Arkansas have not always been as successful as desirable, the results of an experiment at the Fruit and Truck Experiment Station near Hope, on a depleted and eroded Ruston fine sandy loam, prove the soil-building qualities of kudzu.

An experimental planting of crowns was made 10 years ago on a $\frac{1}{3}$ -acre plot to determine whether or not kudzu could be established on poor soil. No fertilization was given at the time, although designated parts of the planting have since been fertilized to determine the effect of the fertilizer on the growth of the plant. No yields have been taken and the leaves and vines have been permitted to accumulate as they died.

In June 1940 samples of soil were taken from the unfertilized area in which the kudzu was growing,

from an adjacent unfertilized area that had been planted continuously to cotton for 6 years, and from an adjoining area that for 10 years had been devoted to Bermuda grass and lespedeza as a soil protecting cover.

The 4-inch layer of organic matter in varying stages of decomposition which has accumulated in 10 years in the kudzu planting can be seen in the accompanying photograph. This dense mat of organic matter would be in itself a good cover to prevent soil washing. The incorporation of the organic layer plays an important part in the rebuilding of the soil.

The results of analyses on the soil samples for total nitrogen content show the value of two legumes, kudzu and lespedeza, in soil conservation practices. The surface soil, $6\frac{2}{3}$ inches deep where kudzu was grown, contained 1,240 pounds of nitrogen per acre. In contrast the soil cultivated continuously to cotton contained only 780 pounds of nitrogen per acre $6\frac{2}{3}$ inches deep. The soil devoted to Bermuda grass and lespedeza contained 1,280 pounds of nitrogen in the surface layer. An average difference of almost 500 pounds of nitrogen per acre can be attributed to the legumes.

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BOOK REVIEWS AND ABSTRACTS

by Phoebe O'Neill Faris

THE BIOCHEMISTRY OF SYMBIOTIC NITROGEN FIXATION. By Perry W. Wilson. University of Wisconsin Press, Madison. 1940.

Although this new book is produced by a true scientist, and in spite of its precise title, one does not need to be a biological chemist, or any kind of chemist, to understand its implications—that human and animal populations require protein, that the amount of nitrogen in the soil limits protein in a given crop, that nitrogen is the element about which proteins are constructed, and that the “nitrogen budget” of the United States is badly in need of balancing. According to Professor Wilson’s analysis, the leaks in the nitrogen cycle through erosion, leaching, sewage waste, etc., in this country could not be plugged up had we at our disposal all the synthetic nitrogen in the world. It is clear throughout the volume that the author is of the opinion that we must take care of leaching and erosion losses and at the same time gain nitrogen through every possible means in order to maintain the green plant upon which permanence of our human society is dependent. The biological fixation of atmospheric nitrogen through the association of leguminous plants with bacteria is the subject of the 300-page monograph which, incidentally, includes one of the best reference lists to be found anywhere—there are 730 entries.

The Lipman and Conybeare “Balance Sheet of Nitrogen for Agricultural Areas of the United States” is shown in chart form and pointed out as evidence that “there must be a reform in land policy if bankruptcy is not to ensue”—nitrogen bankruptcy. It is through his discussion of this deficit in the “nitrogen budget” of our country that Professor Wilson leads to a most interesting historical account of leguminous plants in world agriculture from ancient days to the present. Varro (116–28 B. C.) is quoted on legume cultivation; Columella on alfalfa; Yarranton on clover in England in the 1600’s; Davy on agricultural chemistry in the early 1800’s; Boussingault, who converted his Alsatian farm into the first agricultural experiment station, on his notable experiments on fixation of atmospheric nitrogen. Many curious facts are brought out in this historical section, especially many curious errors; yet it does give a vivid impression of the slow evolution of scientific thinking.

The author’s presentation of the many controversial studies of the past century and a half leads adroitly to the present decade with its problem of discovering the real facts about “how the living organism transforms with apparent ease the inert nitrogen molecule into reactive compounds * * *”. The book is exceptionally well balanced, and certainly the subject as presented is a challenge to scientific thinking. Professor Wilson’s style of writing is sympathetic even as he chides research scientists for refusing to take the leadership in great problems of the day; it is persuasive in that it gently leads on even the layman reader in the desire to understand the role of nitrogen in human existence.

Over 200 pages of the book, the main part of it, are devoted to what is now known about the “partnership” that apparently exists between leguminous plants and root nodule bacteria in the process called nitrogen fixation. Professor Wilson approaches the subject in straightforward manner, by discussing separately the characteristics as revealed thus far by investigation and experimentation of the bacteria that cause root nodules to form. Then in a chapter, “Interaction of Host and Bacteria,” he presents in great detail the “major steps by which the bacteria invade the plant, form nodules, and fix nitrogen.” A chapter immediately following summarizes recent studies of nitrogen fixation by the root nodule bacteria and the leguminous plant. The author allows three possibilities with respect to the mechanism of the process: First, that the bacteria provide nitrogen to the plant in exchange for carbohydrate from the plant. Second, that the bacteria in invading the plant “merely arouse in the cells of the host a function that would otherwise remain dormant.” Third, that the fixation process is a “truly cooperative function of the two organisms,”

and that, without the other, each would be helpless in the transfer of atmospheric nitrogen to the soil.

These three possibilities are carried through several chapters discussing the known facts about the means by which the bacteria invade the plant, the relationship between them, the agent of fixation, and the properties of the enzyme system. These chapters will interest the research scientist chiefly; yet it cannot be denied that there is something inspiring even to the layman in the search for that thus far unknown quantity, the mechanism of nitrogen fixation.

This book is truly well planned. Throughout those chapters dealing with biochemical experiments Professor Wilson has consciously avoided reference to practical application of results. But in his final chapter, a long one, he has presented the agronomic features of the use of legumes and their relation to biochemical research. The associated growth of legumes and nonlegumes is discussed at some length and includes field results of corn and soybeans grown together, oats and peas grown for hay, vetch and oats, wheat and vetch, and other combinations whereby it is hoped that in time more can be learned about the excretion of nitrogen by a growing legume to an associated nonlegume.

Pasture mixtures are given a special section, not as to whether or not mixtures are desirable but, rather, what are some of the mixtures most desirable for improving soil structure and increasing soil organic matter, for controlling erosion and run-off water most effectively, for higher protein and other food elements, for greater yield, and for maintenance of superior species. Results of experiments, some of them controversial, on free versus combined nitrogen in mixed cropping and for nutrition of legumes are given also in this chapter on practical applications, while in his concluding observations Professor Wilson points out the importance of solving within the near future some of the still puzzling problems with regard to nitrogen fixation by legumes and the effects of other chemical and biological processes upon the mechanism. Thirty-four plates, 27 figures in the form of graphs, charts, and drawings illustrate this volume.

DRAINAGE AND FLOOD-CONTROL ENGINEERING, 2d edition. By George W. Pickels. New York and London. 1941.

The first edition of this book appeared 15 years ago. It was designed as a text for courses in land reclamation by drainage. The new edition is only about 75 pages longer, but deletion of a whole chapter on excavating machinery, and other briefer sections, has made way for 125 pages of new or revised material important in design of drainage and flood-control systems and structures.

The chapter on precipitation now includes analyses of excessive precipitation storms up to and including the New England storm of March 1936 and the disastrous Ohio Valley flood of 1937. The storms are divided into the northern and southern groups and are discussed as to geographical and seasonal distribution, area covered, depth, and the relationship of these factors in estimating flood run-off expectancy. Frequency formulas by Meyer, Schafmayer and Grant, Yarnell, and Bernard are compared for accuracy and usefulness in making intensity-frequency charts.

Run-off is treated from the point of view of flood and property damage prevention solely, and the volume is valuable chiefly as a compilation of formulas having to do with flood run-off, stream discharge, water flow in drains and channels, pumping plants for drainage districts, and reservoir location and capacity for prevention of floods. A chapter on drainage law is designed to acquaint engineering students with the general features of the legal phases of drainage districts. Reference lists are given with some of the chapters, and although they have been brought up to date in only a few instances they are nevertheless useful in tracing measurement and design data and heavy precipitation frequency in the United States. About 150 charts, maps, and photographs illustrate the text throughout.

For REFERENCE

Compiled by **ETTA G. ROGERS, Publications Unit**



Field offices should submit requests on Form SCS-37, in accordance with the instructions on the reverse side of the form. Others should address the office of issue.

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Little

SEVERAL thousand miles of stream banks throughout the country have been stabilized by the Soil Conservation Service to demonstrate stream control and conservation of soil along the Nation's waterways. Among plants used for stream bank protection, willows form the first line of defense. There are many species, adapted to various soils and situations, that grow easily from cuttings or poles used in matting the bank. They form a living reinforcement to piling, stone riprap, revetments, and other engineering structures designed to control damaging currents. On small streams the willows may do the job alone. Willows along streams also convert barren banks to protected homes for wildlife and provide food for many wild birds and mammals. Willow buds, for instance, are valuable foods of many upland game birds at seasons when other foods are scarce. Willows are useful to man also, for they have long been employed in basket making, and they are a source of excellent charcoal, now an important element in the construction of gas masks and explosives.

—E. H. GRAHAM.

